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FORTY-FIRST ANNUAL REPORT

OF THE

NORTH CAROLINA

Agricultural Experiment Station

FOR THE

YEAR ENDED JUNE 30, 1918

FORTY-FIRST ANNUAL REPORT

OF THE

NORTH CAROLINA

Agricultural Experiment Station

CONDUCTED JOINTLY BY THE

N. C. DEPARTMENT OF AGRICULTURE

AND THE

N. C. STATE COLLEGE OF AGRICULTURE AND ENGINEERING

FOR THE

YEAR ENDED JUNE 30, 1918

INCLUDING

Bulletins Nos. 238 and 240, and Technical Bulletin 14

LETTER OF SUBMITTAL

RALEIGH, N. C., June 30, 1918.

To His Excellency, T. W. BICKETT,
Governor of North Carolina.

SIR:—I have the honor to submit herewith report of the operations of the Agricultural Experiment Station, conducted jointly by the North Carolina Department of Agriculture and the North Carolina State College of Agriculture and Engineering, for the year ended June 30, 1918. This work is under the immediate direction of the "Joint Committee for Agricultural Work," provided for in chapter 68 of the Public Laws of 1913, and amended by chapter 223 of the Public Laws of 1917, and the report is made in accordance with the requirements of the Act of Congress approved March 2, 1887, and known as the Hatch Act.

Very respectfully,

B. W. KILGORE,
Director.

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BULLETINS:

No. 238—Harvesting Tobacco by Priming or Picking the Leaves as Compared with Cutting the Stalks—By E. G. Moss.

No. 240—Composite versus One-Day Sampling of Milk for the Babcock Test—By W. H. EATON.

TECHNICAL BULLETIN

No. 14—Repair of Bone in Domestic Fowl—By B. F. KAUPP.

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C. B. Williams	Vice-Director Experiment Station
R. W. Collett	Assistant Director Branch Stations
S. G. Rubinow	Assistant to Director Extension Service
F. H. Jeter	Agricultural Editor
A. F. Bowen	Bursar
Miss S. D. Jones	Bursar
Miss Mary S. Birdsong	Secretary to Director
H. C. Evans	Auditor and Executive Assistant

Agronomy

C. B. Williams	Chief in Agronomy
J. K. Plummer	Soil Chemist
W. F. Pate	Agronomist—Soils
E. C. Blair	Assistant Agronomist—Soils
S. K. Jackson	Assistant Agronomist—Soils
R. Y. Winters	Plant Breeding
V. R. Herman	Assistant in Plant Breeding
N. E. Winters	Extension Agronomist
†S. O. Perkins	Assistant in Soil Survey
L. L. Brinkley	Assistant in Soil Survey
†E. S. Vanetta	Assistant in Soil Survey
S. F. Davidson	Assistant in Soil Survey
†R. C. Jurney	Assistant in Soil Survey
W. A. Davis	Assistant in Soil Survey
E. H. Matthewson	Tobacco Expert
A. R. Russell	Asst. in Field Experiments

M. W. Hensel, Specialist in Sugar Plant Production

Chemistry

W. A. Withers	Chemist
———	Assistant Chemist
J. M. Pickell	Feed Chemist
W. G. Haywood	Fertilizer Chemist
E. S. Dewar	Assistant Chemist
R. A. Fetzer	Assistant Chemist
G. L. Arthur	Assistant Chemist

Entomology

Franklin Sherman, Jr.	Chief in Entomology
Z. P. Metcalf	Entomologist
R. W. Leiby	Assistant Entomologist
J. E. Eckert	Assistant Entomologist
†C. L. Sams	Beekeeping
†W. A. Thomas	Extension Entomologist

Horticulture

W. N. Hutt	Chief in Horticulture
J. P. Pillsbury	Horticulturist
L. R. Detjen	Assistant Horticulturist
C. D. Matthews	Assistant Horticulturist

Animal Industry

Dan T. Gray	Chief in Animal Industry
R. S. Curtis	Associate in Animal Industry
Stanley Combs	Dairy Experimenter
B. F. Kaupp,	Poultry Investigator and Pathologist
†A. J. Reed	Dairy Farming
†J. E. Moses	Swine Extension Specialist
†W. W. Shay	Assistant, Swine Extension
†J. C. Anthony	Assistant, Swine Extension
†A. G. Oliver	Poultry Extension
†E. C. Warden	Assistant, Poultry Extension
†J. A. Arey	Assistant in Dairy Farming
†A. C. Kimrey	Assistant in Dairy Farming
†D. R. Noland,	Assistant in Dairy Farming (Cheese Work)
†F. T. Peden	Assistant in Beef Cattle
†J. W. Sloss	Assistant in Beef Cattle
†J. B. Peery	Assistant in Beef Cattle
†Albert Miller	Assistant in Beef Cattle
Earl Hostetler,	Assistant in Beef Cattle and Swine
†George Evans	Assistant in Sheep
†W. H. Fergusgn	Assistant in Sheep
John E. Ivey	Asst. in Poultry Investigations

†F. R. Farnham, Assistant in Dairy Farming (Cheese Work)

Plant Pathology

F. A. WOLF.....Plant Pathologist R. A. JEHLE.....Extension Pathologist

Drainage

†H. M. LYNDE.....Senior Drainage Engineer F. O. BARTEL.....Junior Drainage Engineer

Veterinary

G. A. ROBERTS.....Veterinarian

Markets and Rural Organization

W. R. CAMP.....Chief, Division of Markets
O. J. MCCONNELL.....Specialist in Cotton Marketing
CHARLES S. JONES.....Specialist in Live Stock Marketing
W. W. GARNETT.....Assistant Superintendent of Credit Unions
BOLLING HALL.....Assistant in Marketing Fruits and Vegetables
GORRELL SHUMAKER.....Assistant in Marketing Fruits and Vegetables

Farm Management

†J. M. JOHNSON.....Farm Management

Branch Stations

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F. T. MEACHAM.....Assistant Director Iredell Branch Station, Statesville
W. J. BROCKINGTON.....Assistant Director Pender Branch Station, Willard
C. E. CLARK.....Assistant Director Edgecombe Branch Station, Rocky Mount
E. G. MOSS.....Assistant Director Granville Branch Station, Oxford
S. C. CLAPP.....Assistant Director Buncombe Branch Station, Swannanoa
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Farm Demonstration Work

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R. W. FREEMAN.....District Agent, Southeastern District

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MRS. LIZZIE R. EDGERTON.....District Agent, West Central District
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MRS. ESTELLE T. SMITH.....District Agent, East Central Ditrictt
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Farm Forestry

H. B. KRAUSZ.....Farm Forestry Specialist

Farm Machinery

E. R. RANEY.....Farm Machinery Specialist

The members marked with * are members of the Joint Committee for Agricultural Work, and the Station is under their direction.

†In cooperation with the U. S. Department of Agriculture.

FORTY-FIRST ANNUAL REPORT

OF THE

North Carolina Agricultural Experiment Station

For the Year Ending June 30, 1918

B. W. KILGORE, *Director*
F. H. JETER, *Agricultural Editor*

The North Carolina Agricultural Experiment Station, in common with the other institutions of the State, has just passed through one of the most interesting, though one of the most trying years of is existence. During this period it has tried to be of real active service to the people of the State and its staff of patriotic workers has given freely of its time and efforts to aid the government program of winning the war.

The Station is conducted jointly in North Carolina by the State Department of Agriculture and the State College of Agriculture and Engineering in cooperation with the United States Department of Agriculture. The general administration of its affairs is handled by the joint committee for agricultural work, representing the State Board of Agriculture and the Board of Trustees of the College.

Conforming with the policy of practically every educational institution, during the year ending June 30, 1918, the Station has lent its services largely to the solution of those agricultural problems arising as a result of the world war, and its staff has felt to the fullest extent that, in so far as possible, they should lend aid to the very important task of placing agriculture on a firm basis, in order to meet the war-time and after the war demands of the nation. However, none of the valuable experimental work now under way has been seriously neglected, nor has a study of future problems been overlooked.

As heretofore, the Station has sought to anticipate the needs of the farmers of the State; and, while it has engaged in experimental work of a practical nature, which would make available ready information to be carried by the Extension workers directly to the farmers, it has also studied those technical problems indirectly related to the every day practical problems, but which serve to give additional information about the obscure truths of agriculture from which an application of these to the practical agriculture can be deducted.

Considerable progress has been made on a number of the projects now being studied. With the experimental work and extension work being closely allied, as they are, it is easily possible for the extension workers to take this information directly to the people of the State.

CHANGES IN STAFF

There have been few changes in the staff since the time of the last report. Most of these have been occasioned by the workers severing their connection with the institution to go into the military services of the nation, and by others finding more remunerative positions in other organizations. These changes are mainly as follows:

Dr. F. A. Wolf, Chief of the Division of Botany and Plant Pathology, was given a leave of absence for the period of the war, his place being filled by Dr. W. H. Tisdale, who became Associate Chief of Division. Mr. A. C. Foster, Assistant in this Division, also resigned during the year to enter the Army Medical School at Washington, D. C.

Mr. R. G. Hill was transferred from the Division of Horticulture to become superintendent of the Pender Branch Station, and resigned that place to take up work with the Federal Department of Agriculture. He was succeeded at the Pender Station by Mr. W. J. Brockington, formerly County Agent in Wilson County.

Dr. J. K. Plummer, Soil Chemist, was given a leave of absence to engage in chemical research work for the War Department.

Mr. F. E. Carruth resigned to go with the Federal Department of Agriculture.

Mr. W. N. Hutt, Chief of the Division of Horticulture, resigned during the year to go into commercial work within the State.

Mr. R. O. Cromwell, Assistant in Plant Disease work, severed his connection with the Station during the year to accept a position with the Nebraska Station.

Mr. F. O. Bartel succeeded Mr. F. R. Baker in the Drainage Division, when Mr. Baker accepted a commission in the regular army, and Mr. Bartel afterwards entered the military service.

In the Marketing Division, Mr. Charles S. Jones became Specialist in Livestock Marketing, and Mr. W. W. Garnett was made Assistant Superintendent of Credit Unions, due to the resignation of Mr. J. A. Livingston. Mr. Gorrell Shumaker also entered the military service and returned after the armistice.

Mr. W. H. Eaton resigned during the year as Dairy Experimentalist to take up Dairy Extension work in Alabama. He was succeeded by Mr. Stanley Combs, formerly Assistant in Dairy Farming.

Messrs. R. A. Fetzer and G. L. Arthur became Assistant Chemists on the resignations of Messrs. J. Q. Jackson and T. M. Hill to enter the army. Mr. Jackson died in the service at Camp Upton, N. Y.

INTERESTING RESULTS SECURED

As has been stated, many of the different divisions have succeeded in working out much authoritative data on the different questions in which the farmer is vitally interested; this being given to the press and to the

public through news stories; weekly issues of the *Extension Farm News,* and bulletins of the Agricultural Experiment Station, the State Department of Agriculture, and the Agricultural Extension Service.

Particularly valuable have been the results of the investigations concerning beef cattle on the farm of T. L. Gwynn in western North Carolina. It has been found here that beef cattle may be grazed in the mountains during the winter, and that they meet the spring in a much better condition than when simply carried over by maintenance rations.

The establishment of the experimental farm with sheep at Spruce Pine, in Mitchell County, during the year, has also put the Station in line for securing valuable data in regard to this phase of animal husbandry. About two hundred head of sheep are under observation at the present time on this farm.

The results of the investigation as to the cause of milk sickness in animals in the western part of the State have been worked out in a very exhaustive manner, it being determined that the disease is caused by the cattle eating of a weed known as Eupatorium urticæ-folium or White Snakeroot. The results of these investigations have been published in Technical Bulletin No. 15, which gives methods of control of this heretofore little known disease.

A continuation of the potato spraying work, both in the western and in the eastern parts of the State, where two crops per season may be grown, has proven conclusively that it pays to spray for both disease and insect pests, and that increased gains of 50 per cent crops of potatoes may be gained by this practice.

Investigations as to rural credit have been continued in the Division of Markets, with the sixteen Credit Unions now operating in the State.

It is worth while to observe that the membership in these organizations has increased from 514 in 1917 to 653 in 1918, with the number of depositors now being four times what it was then, and a greatly increased buying of shares, with an increase also in the total amount of deposits. The money now paid in on shares amounts to $7,512.77. This amount was a little over $2,000 in 1917. The total deposits have increased from about $2,000 to over $11,000, and loans and borrowers have also greatly increased. In fact, the total resources of the Unions now amount to $24,618.69, while in 1916 this amounted to only $7,471.42.

The investigations of the disease known as "wildfire" in tobacco have resulted in much valuable information being accumulated, and the Division of Plant Pathology has been able to give advice as to the growing of a crop of tobacco free from this trouble. The great losses in tobacco which occurred during 1917 from this disease, makes this investigation of particularly high value.

The losses of beans and peas from weevils have been reduced, as a result of investigations by the Division of Entomology in the use of lime and heat to control these pests.

Much aid has been rendered by the Experiment Station to farmers in different counties in the cooperative marketing and shipping of livestock,

notably hogs, to out-of-State markets. In this, the Livestock Specialist first has made exhaustive surveys, and, then, in cooperation with the county agent of the Extension Service, has had several farmers to go in together to make up shipments of carloads of hogs, thus aiding the small grower, as well as the larger producer.

There has been a notable increase in the acreage of soybeans in the State, due to the investigations of the Division of Agronomy in regard to the culture and variety studies of this important North Carolina crop. Increases of from 50 to 100 per cent are common in most counties, and some have made increases as high as 500 per cent.

The work of the Division of Agronomy in crop variety tests has also been important. This has proven to be one of the most valuable phases of experimental research, in that it has furnished the farmers of the State definite information about the varieties of any crop best suited to local conditions. Those who have adopted the suggestions being worked out are increasing their crop yields very much by this one method alone.

From this work has come the community improvement of cotton that is now being carried on by twenty communities in eleven counties by members of the Agricultural Extension Service. This work has caused the growers to be able to produce cotton of higher quality, and in greater quantity, resulting in increased profits from the growth of this crop

The establishment of home orchards by the Extension Service has also been made possible by the investigations as to the different varieties of fruit best suited to the several sections of the State. One hundred and six of these home orchards were established during the past year on the basis of the investigational work which has been conducted.

The organization of breeding associations in five of the counties is another feature of interest founded on the investigational work now being conducted with livestock.

Potato house construction, as a direct result of the investigations at the Pender Branch Station, has also received a decided impetus. A campaign for these storage houses was made during the year, in cooperation with the county agents of the Extension Service, and the Division of Horticulture reports a total of around 75 houses constructed, with a total capacity of over 100,000 bushels.

The work of culling poultry has been demonstrated to the people of the State, as a result of investigations by the Animal Industry Division. Many birds have been discarded without the expense of trap nesting. During these war periods, when all feed is scarce and high in price, this work alone has been of much practical value.

The Experiment Station workers also have lent much aid to the movement of increasing the sheep population of the State, their efforts resulting in an increase of about 3 per cent in the number of sheep in North Carolina during the past year. As all of the vital problems affecting this industry are being studied both at the central farm and on the Mitchell County farm, the Station expects within a short while to be able to give accurate authoritative data in regard to many of the questions affecting the handling and raising of sheep in this State.

BRANCH STATIONS OF GREAT AID IN EXPERIMENTAL WORK

North Carolina is particularly fortunate in that it has a system of branch experiment stations located in the different sections of the State, making it possible that all questions of the State's agriculture may be studied in the section where these questions are likely to be of the greatest importance. These six branch stations are supported directly by the State Department of Agriculture, the work being in charge of a superintendent who carries out the work of those Experiment Station workers who have problems under investigation on that particular branch station farm. Heretofore, these branch stations have been known as test farms, but, as the work has assumed more and more importance, and the equipment has grown in value, it has been decided to give them the dignity of branch stations, with the following designations being given:

Mountain Branch Station at Swannanoa, in Buncombe County.
Piedmont Branch Station at Statesville, in Iredell County.
Truck Branch Station at Willard, in Pender County.
Coastal Plain Branch Station at Rocky Mount, in Edgecombe County.
Tobacco Branch Station at Oxford, in Granville County.
Muckland Banch Station at Wenona, in Washington County.

Investigational work on these farms is on a good basis, and much valuable data is being accumulated.

AGRICULTURAL MEETINGS HELD AND ATTENDED

During the year the Experiment Station workers have also been very active at many of the larger agricultural meetings of the State. While most of these meetings were arranged by Extension workers, the investigational men have been called upon to take part and to give the results of their work. These meetings have been in the form of farmers institutes, patriotic sheep meetings, food and feed production meetings, livestock conferences, club rallies, and farmers picnics.

The Farmers Convention at West Raleigh, during August, had one of its most successful meetings, with the Experiment Station workers appearing on the program at all of the important sectional conferences.

The Annual Livestock Meeting at Wilson gave promise of being one of the most successful of recent years, but on account of inclement weather, many farmers were deterred from attending. In spite of this, however, much good was done by the selling of several consignments of pure bred hogs and cattle, and in increasing the interest about pure bred livestock in the eastern section of the State. This was reflected later by the banks of the section taking up the matter with the farmers, and calls then being made on the Extension Workers for buying several carloads of pure bred dairy and beef cattle from out-of-State markets.

At least forty carloads of western cattle were brought into the State during the summer, with most of these going into the eastern district.

VALUABLE COOPERATION GIVEN STATION

It is also timely to state that the Experiment Station is particularly fortunate in having the close cooperation of many of the State institutions, the State press, business organizations, and other organizations and individuals in working for the advancement of agricultural development. It has enjoyed the closest cooperation of the daily, weekly and agricultural press, of the railroad workers, of the State banks, the Chambers of Commerce, and of those educational institutions on which it relies for support and encouragement.

It is not out of place also to mention here that many of the larger papers of the State have issued BETTER FARMING SPECIALS, opening their columns to signed articles from the Experiment Station workers, and that they have used freely the material supplied by the weekly *Extension Farm News,* and by the daily press service.

The people of the State, as a whole, have responded freely and without stint, during the year, to all of the calls which have been made upon them, the farmers particularly showing patriotism of the highest type by putting in as many acres of food crops as they could possibly cultivate and handle, and by laboring unselfishly in furthering the food production program of the nation.

AGRONOMY

The Division of Agronomy continues to study the soil and fertility problems of the State, devoting considerable attention also to the selection and breeding of better crop varieties, and of determining the fitness of these for the different soil conditions. During the past year it has completed soil surveys in Bertie, Wilkes, Orange, Hoke, and Caldwell counties, while at the present time a party is at work in Vance County, and another member of the division is making a base map of Nash County for the commissioners.

Fertility experiments are being conducted with different crops on many of those soils of the State which have been previously mapped to show the fertilizer requirements of the soil, and the plant food deficiencies.

As to carriers of plant food, the studies on most of the farms indicate that nitrate of soda, followed by sulphate of ammonia, are the most efficient carriers of nitrogen, while acid phosphate is a much more economical carrier of phosphoric acid than is the finely ground phosphate rock. This latter fact is shown to be true on practically all of the farms of the State, as the acid phosphate is giving greater and more economical crop yields. The use of lime is also showing up to excellent advantage.

Crop improvement work is being carried on by field selection and breeding at each of the seven experimental farms, and from it good increases in crop yields have been secured from the selected strains.

With tobacco, experiments show that many more plants could be put on the same area of land than is now commonly practiced, thereby greatly increasing the average yield. It has also been ascertained that the priming of the tobacco leaves is much more to be desired than cutting the whole stalk, as gains of as much as 240 pounds per acre have been made where the practice of priming has been followed. Considering the present prices of tobacco, this is an important fact for the average tobacco farmer to know.

The test of the varieties of tobacco show that most of the so-called varieties are all more or less closely related to the original Orinoco type, but that the best varieties usually give from 100 to 200 pounds more tobacco per acre than the poorer ones.

A soil and fertility report has been completed for the Coastal Plain Section of the State, and issued as the May, 1918, bulletin of the State Department of Agriculture.

CHEMISTRY

The chief efforts of the Division of Chemistry, during the year, have been devoted to a compilation of the results of the experimental data accumulated during previous years. It has published several articles about the toxicity of cotton seed and its products, most of these having to do with the conclusions which have been reached in a study of "gossypol."

Samples of cottonseed meal have been secured from various mills in different sections of the State, and the subsequent tests have shown that there has been a considerable variation in the amount of toxic substances in the different samples. It appears that this is partly due to the method of manufacture of the meal, as well as in the original difference in the seeds.

Experiments also indicate that meal for commercial purposes may be manufactured so that the toxicity may be reduced to inappreciable amounts. This latter phase is being studied carefully and fully in order to arrive at more definite conclusions on the subject.

ANIMAL INDUSTRY

The investigational work of the Animal Industry Division is divided among the different offices of the Division, and is concerned with the handling of beef cattle and sheep, dairy cattle, poultry, swine, horses, and mules.

In the work with beef cattle and sheep, probably the most outstanding feature, has been secured on the farm of T. L. Gwynn in Haywood County, where the winter grazing of livestock has been studied, together with the effect of these different methods upon the cattle during the following summer. The data secured on this farm has proven that by the use of a pasture mixture consisting largely of orchard grass, the cattle may be carried through the winter and meet the spring pastures

in a much better condition and at a much cheaper cost than when fed on harvested feeds such as corn stover, cottonseed meal, or other feeds supplied as a maintenance ration.

In cooperation with the Division of Plant Pathology, considerable work also was done on the feeding of animals with the white snakeroot plant, in order to obtain definite data on the disease known as trembles or milk sickness, which occurs, to a great extent, among livestock in western North Carolina.

The establishment of the Spruce Pine farm in Mitchell County is putting the Division in line for securing much valuable data on the best methods of growing and feeding sheep in the mountains, both during the winter and summer. This farm, under the direction of Mr. W. R. Radford, as superintendent, has, during the short time it has been established, been of great local value.

A change in the dairy investigations, due to the resignation of Mr. W. H. Eaton, caused a temporary adjustment in the studies being made in this office.

Mr. Stanley Combs, the present dairy experimentalist, is devoting his time to the Pender dairy herd, making an effort to inject better care and business principles into its management. He has on hand at the present time 44 animals in this herd, many of which are calves and other young stuff. The dairy will be built up to a permanent 30 cow establishment, after which all of the problems in connection with the conduct of a dairy will be thoroughly studied.

At the present time, there is being accumulated much authoritative data on the cost of milk production, the cost of raising dairy heifer calves, and the removal of onion flavor from the milk and butter.

The poultry office has over 20 projects under investigation, one of which, on the anatomy, physiology and histology of the domestic fowl, has been of such value that Dr. B. F. Kaupp has recently been able to complete a book on this question, which is a standing contribution to scientific literature. All of the laboratory work in connection with the preparation of this manuscript was done at the Station.

Many other studies, such as breeding for egg production, the value of different feeds, the culling of birds based on physical indications, methods in fattening and shipping fowls, together with the handling and shipping of eggs, are all being studied both at the central experimental poultry farm and the Iredell farm.

The work with swine has to do largely with the production of cheap pork by the utilization of permanent and temporary pastures, and the affect of these pastures upon the bodies of hogs, together with a study of the use of feeds for hardening the bodies. Different methods of curing meats have also been carefully investigated throughout the year.

The Animal Industry Division has been unusually active during the past year, with the men of the staff taking part in all of the campaigns for increased production of meat and fats, and this activity meeting with some degree of success.

ENTOMOLOGY

While the workers in the Division of Entomology have spent considerable time during the year in activities of an extension nature, due to the necessity arising for a better knowledge of insect control on account of war conditions, still the main projects of investigational work are being continued.

Some of the principal projects are a study of pecan insects; a continuation of the studies in connection with the life history, habits, generations, and other questions concerning the corn stalk borer, together with the methods for control; tests with the spraying of potatoes; the dusting of cabbage to control worms, and a survey of the insect life of the State.

Under the Hatch and Adams funds, considerable work has also been done with the gloomy scale, bean and pea weevils, melon beetles, the tobacco flea beetle, and insects affecting ornamental plants.

To a less extent, the soap and water remedy for aphids, field studies of the black corn weevil, and observations on the control of mosquitoes and flies also have received attention.

Many tests have been made during the year for the control of the different insects affecting the pecan, and the application of several remedies so as to secure the best protection for the pecan orchards of the State from the ravages of these insects.

The potato spraying work has been extremely valuable in that the extension workers have been able to take the findings from this work and apply them in demonstration work with the potato growers in both eastern and western North Carolina. Increased yields amounting to at least 50 per cent have been secured from these sprayings.

In the insect survey of the State at least 2,000 species or kinds of insects have been collected and records secured to show that there are at least 5,000 species not known to be native of the State.

The study of mosquitoes and flies, in connection with the sanitary work of the Public Health Service, has been observed so that this work may be undertaken after the war emergency period is passed. Particular attention has been directed to the drainage of standing water, so as to lessen the breeding of mosquitoes, and many specimens have been collected for the purpose of ascertaining the particular kinds present in the several sections of the State.

It has been found in the work with the gloomy scale that a small wasp will kill as high as 98 per cent of the scale on a shade maple, but this wasp is not present to any beneficial extent every year, therefore spraying during the dormant period must be relied upon for practical control.

With bean and pea weevils, it has been found that it is necessary to control these either by the use of air-slaked lime, or to kill the weevils by artificial heat.

The melon beetles have been studied now for three years, in cooperation with the Division of Cereal Crop Insects of the United States Bureau of Entomology, and it has been found that the grub of one particular kind of this beetle is very destructive to corn, making it necessary that a relation between the time of planting corn and destruction by the crop of this insect be carefully observed. Plats are being used on five of the different branch stations in working out this problem.

To control the tobacco flea beetle, at least four different methods have been advocated in a manuscript which is now ready for printing, and which will give in detail the work done on this problem.

Investigations with the control of Hessian Fly in wheat have reached a point where the results from this work have been turned over to the Extension Service, and a bulletin has been issued by the State Department of Agriculture showing in detail the safe dates for sowing wheat to escape injury by this pest, yet give good yields.

HORTICULTURE

One of the most valuable projects now being studied by the Horticultural Division concerns itself with the value of the pecan as a commercial crop in North Carolina. It has been found that the experimental orchards in the Coastal Plain section of the State produce their first commercial crops at eight years of age, and the results secured indicate that in so far as it is planned to grow the pecans for commercial purposes, the orchards should be confined entirely to the Coastal Plains.

In the variety tests with these nuts, twenty-two of the most important varieties have been tested for eleven years, and much valuable information in regard to the best varieties for the State has been secured. Most of those varieties which flourish in the Gulf Coast section are almost worthless in North Carolina, because of the shorter growing season. Other studies in which the individual performance of the tree is being regarded, cultural practices being studied, the cracking quality of nuts being tested, and questions relating to working and breeding, are all proceeding in a satisfactory manner.

At least 60 different varieties of peaches are under investigation at the trucking branch station for the purpose of producing early maturing varieties, earlier free-stone varieties, and varieties which are harder in the bud and have a longer resting period. Much work also is being done in pruning and dehorning peach trees.

The investigational work in the thermal zones, which has been conducted since 1909, was completed in 1916, and at the present time a topographical map of parts of western North Carolina are being prepared showing the valuable fruit zones on the elevation between 1,500 and 3,500 feet. This work is of great value to those people who wish to secure land at suitable altitudes for commercial orcharding.

The Division is also doing some important work in studying the various varieties of pomological fruits, in determining the native fruits

of North Carolina, in studying about 23 varieties of strawberries, in comparing varieties of sweet potatoes, together with different methods of storage, and in improving and storing different varieties of Irish potatoes in the State.

The work on the experimental vineyard at the truck branch station is making good progress in that several of the most desirable varieties of rotundifolia grapes have been determined, and many improved strains bred from the existing varieties.

PLANT PATHOLOGY AND BACTERIOLOGY

The report on plant pathology and bacteriology work during the year is necessarily condensed on account of the absence of Dr. F. A. Wolf, who was given leave of absence to accept a commission in the medical corps of the army.

Before leaving, however, Dr. Wolf secured considerable data on the bacterial disease of tobacco affecting the foliage and resulting in the formation of large decayed spots. This disease is known locally as "tobacco wild-fire," and specimens have been collected in 19 counties of the State. The studies made show that the disease originates in the plant bed and is conveyed to the field at transplanting. It spreads more rapidly at times of continued heavy rain, when accompanied by wind.

The results of the investigations with trembles or milk sickness indicate that those animals affected were poisoned by eating a plant known as the white snake-root. Considerable data have been accumulated in regard to this work, and the results published in Technical Bulletin 15, issued in July, 1918. The disease has been known in the State for around 150 years, but up until this time no readily acceptable explanation could be given for its cause.

The only other project of considerable importance was a study of the bacterial blight of soybeans, which spreads rapidly in the buds during splashing rains.

MARKETS AND RURAL ORGANIZATIONS

The investigations of the Division of Markets and Rural Organizations have been concerned, as heretofore, with problems of marketing, rural credit, and the grading of products. Many investigations have been made in regard to the prices received for cotton, the distribution of North Carolina cotton, the shipping of damaged cotton, and the need for warehouses.

In marketing livestock, a survey of the swine population and the marketing conditions over the State has been made, showing that 61 per cent of the hogs in the State are contained in 39 counties of the eastern section. There are very few local markets, and for this reason the cooperative marketing in car lots is being encouraged, in cooperation with the county agents of the Extension Service.

The office makes a monthly survey of prices received by producers for corn, cotton, potatoes, hogs, peanuts, soybeans, and eggs, and this is issued each month for publication in the press and for sending to individual farmers.

In organization work, a Mountain Growers Exchange was formed at Waynesville in the fall of 1918 for the purpose of handling the potatoes, apples, and other farm products for the members. This exchange has had the effect of raising the price of potatoes in the Waynesville section 50 cents a sack, both to the members of the exchange and to the nonmembers in the vicinity.

The Edgecombe Cotton Exchange, which was organized in 1915, has also been of much value during the year to the farmers in the vicinity where it is at work.

Four new Credit Unions were organized, making 18 now in operation. These have enjoyed a great measure of prosperity.

During the year the office has classed 47,923 bales of cotton, and has rendered active assistance in the sale of about 12,000 bales. Due to the fact that the Division has informed cotton mills where they could obtain cotton of particular grade and staple, reports secured indicate that this service has been worth at least $150,000 in direct monetary returns to the producers. In fact, merchants, small buyers and local mills have all profited by the cotton marketing and grading service as it is now being conducted.

In addition to other work, the Division has rendered assistance in the cooperative marketing of 10,478 barrels of early white potatoes, 1,800 sacks of late white potatoes, 10,380 barrels of sweet potatoes, and 10,820 crates of strawberries, and 10 cars of corn. Farmers have been assisted in buying 17 cars of hogs and in disposing cooperatively of 10 cars.

The Division has continued to issue its market news service, its weekly price reports, and its regular market bulletin, all of which have proven to be of some value in the handling of farm products. This work has been done in cooperation with Bureau of Markets for the United States Department of Agriculture.

DRAINAGE

Work in the Drainage Division is conducted chiefly along the same general lines as heretofore, except that experimental maintenance work begun in 1917 was discontinued on account of war conditions. Due to the resignation of Mr. F. R. Baker, Mr. F. O. Bartel was elected as Junior Drainage Engineer.

During the year the Division has located approximately 76,200 feet of tile on 42 farms in 23 counties; this tile drains a total area of 2,400 acres. The Division has also given assistance in the location and construction of terraces to prevent hillside erosion on 20 farms. Around 181,000 feet of terraces have been laid out. This work, together with a

study of the efficiency of under drains, and the accumulation of data on drainage canals is the principal lines of work engaged in. In addition, however, three examinations have been made for large drainage districts comprising the total area of 14,400 acres. Progress has also been made in the assembling and plotting of this data in the summarizing of the results.

PUBLICATIONS

With the exception of the Annual Report, only three publications have been issued during the year.

Bulletin No. 238, "Harvesting Tobacco by Priming or Picking the Leaves as Compared With Cutting the Stalks," with 11 pages, was published in an issue of 15,000 copies.

Bulletin No. 239 was withdrawn from the press, and later issued as a State Department Bulletin because of lack of funds in the Experiment Station.

In the meantime, however, Bulletin No. 240, "Composite vs. One Day Sampling of Milk for the Babcock Test," containing 8 pages, had been printed, with a total issue of 15,000 copies.

Only one Technical Bulletin was published. This was Technical Bulletin No. 14, "The Repair of Bone in Domestic Fowl," containing 17 pages, and printed in an issue of 3,000 copies.

In addition to these publications, however, the experimental work of the Station has been kept before the public by means of articles in the *Extension Farm News,* and in the daily mimeograph articles to the press. Many multigraphed letters and circulars have been distributed, especially during the past year, because of the great efforts made to increase all food and feed production as a war measure. The total number of names in the mailing lists approximate 75,000, and these are kept active and up to date at all times.

The reports of the heads of the several Divisions and the financial statement follow:

FINANCIAL REPORT

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

in account with

THE UNITED STATES APPROPRIATIONS, 1917-1918.

DR.

	Hatch Fund	*Adams Fund*
To receipts from the Treasurer of the United States, as per appropriations for the fiscal year ended June 30, 1918, under acts of Congress approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund)	$15,000.00	$15,000.00

CR.

Salaries	$ 7,176.63	$12,579.04
Labor	2,913.04	1,030.55
Publications	81.18	.....
Postage and stationery	230.56	119.72
Freight and express	17.28	39.70
Heat, light, water, and power	183.25	161.50
Chemicals and laboratory supplies	191.06	170.42
Seeds, plants, and sundry supplies	302.52	254.85
Fertilizers	602.66	376.98
Feeding stuffs	1,771.42	.....
Tools, machinery, and appliances	738.87	105.44
Scientific apparatus and specimens	61.50	93.18
Traveling expenses	276.29	68.62
Contingent Expenses	20.00	.....
Buildings and land	433.74	.....
Total	$15,000.00	$15,000.00

The North Carolina Agricultural Experiment Station

in account with

Farm and Miscellaneous Receipts

Dr.

Receipts from other sources than the United States for the year ending June 30, 1918	$8,087.83
Balance on hand	839.00
Total	$8,926.03

Supplemental Statement.

Cr.

Salaries	$ 131.67	
Labor	216.35	
Publications	.90	
Postage and stationery	23.10	
Freight and express	95.83	
Heat, light, water, and power	22.08	
Chemicals and laboratory supplies	.60	
Seeds, plants, and sundry supplies	81.76	
Fertilizers	4.60	
Feeding stuffs	1,660.88	
Library	243.12	
Tools, machinery, and appliances	1,102.55	
Furniture and Fixtures	378.07	
Livestock	1,950.90	
Traveling expenses	106.60	
Contingent expenses	5.90	
Buildings and land	1,284.42	
Balance	1,616.70	
		$8,926.03

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accouns of the North Carolina Experiment Station for the fiscal year ending June 30, 1918; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasury of the United States are shown to have been $30,000, and the corresponding disbursements $30,000, for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving nothing.

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress, approved March 2, 1887, and March 16, 1906.

(Signed) W. H. Ragan,
W. B. Cooper,
T. T. Thorne,
Auditors.

(seal)

Attest: A. F. Bowen, *Custodian.*

REPORT OF THE DIVISION OF AGRONOMY

To the Director:

The main lines of work, as indicated in previous reports, have been along lines of mapping the soils of the State; of placing experimental work with different crops and fertilizers on the leading types of soil; of determining the best varieties of different crops for different conditions; and of selecting and breeding better strains of the leading crops for North Carolina conditions. In all of these different lines there has been considerable progress.

MAPPING AND ANALYZING THE SOILS

Under this project comes the soil survey, in which it is planned to map all the soils occurring in the State into different groups or classes according to the main distinguishing characteristics they may possess. Up to this time, something like one-half of the soils in the State have been mapped. During the past year, surveys of Bertie, Wilkes, Orange, Hoke, and Caldwell counties have been completed. At the present time, a party is working in Vance, and another member of the Division is making a base map of Nash County for the county commissioners.

In this soil survey work, after the mapping of each county has been finished, the map is issued showing the exact boundary of the different types of soil occurring in the area. The report attached includes such information as has been carefully collected by the field men with reference to the characteristics of the different crops. This work is basic to the systematic field work that is being conducted both in soil fertility studies and crop adaptation experiments. It would not be possible to carry on these latter lines of work most intelligently and effectively were they not planned with reference to soil types.

The soil survey parties, before leaving an area, after the map of the county has been completed, draw samples of soil from each type occurring in the area, sending these samples to the laboratory for analyses. These, when completed, show potentially what are the main plant-food reserves of the soils in the area which has been surveyed. It does not necessarily follow, however, that the chemical analyses of the soils are a sufficient guide in determining what are the immediate plant-food requirements of the soils for profitable crop production. As a matter of fact, the only certain guide to this information is secured by growing plants upon the different soils. The chemical analyses, however, are valuable in making safest deductions from field experiments with crops using different fertilizing materials.

For instance, if the chemical analyses of a soil show it to be well supplied with potash for the growth of ordinary crops for many years, yet the results show this particular soil to be in need of this constituent, then the agronomic question is not so much the supplying of potash, in the

long run, but the making of the soil conditions so as to favor bringing into form the store of potash that is present in a form or forms that the plant cannot secure at the present time. Again, if the crops show a soil to be not greatly benefited by a constituent which it contains in very limited amounts, as is the case with phosphoric acid with many of the soils in eastern North Carolina, then it can be readily seen that it will only be a very short time until all of the phosphoric acid would be used up and that the analyses of the soils help greatly in making safe and sound the deductions from the field results.

SOIL FERTILITY EXPERIMENTS

As indicated above, after the mapping of the soils has been finished, the next problem is that of determining the plant-food needs of the different soils for the economic growing of different crops suitable for growth in the area. The safest way generally to determine these needs is by means of carefully conducted field experiments. At the present time, the Division is carrying on a large amount of this kind of work in different parts of the State. The results of these experiments on any particular kind of soil in any locality will generally have wide adaptation to the same type occurring in the same county, as well as when found in another section of the State; but they may or may not have value to those farmers whose farms are located on an entirely different kind of soil from that of the particular type on which the experiments were conducted, even when the farms are located in close proximity to the experiments.

In our experimental work, there are many striking illustrations of this fact. For instance with the Iredell Loam type of soil occurring in Mecklenburg County, it has been found in carefully conducted field trials with this particular type that it is not benefited by applications of phosphoric acid while the Cecil series of soils which is the predominating type in that county have shown that phosphoric acid is the limiting constituent in crop yields, and that ordinarily where the most profitable returns are to be secured, materials carrying this constituent in an available form must be applied to the soil.

The plan followed in this work heretofore is that after field experiments have been continued for a sufficient length of time to give results that can be depended upon, they have been brought together and published with a general summary. Later reports have been published for the three main soil provinces of the State giving a description and analyses of the soils occurring in each and pointing out as well the main plant-food deficiencies of the main types growing in each province. These later publications are to be followed by a series of publications giving specific information with reference to the needs of the soils, how best to apply this information, and what crops and crop rotations are best to use in the different counties. Up to the present time, four such reports have been issued, they being for the counties of Mecklenburg,

Gaston, Cabarrus, and Union. It is planned to issue this series of reports as rapidly as they can be prepared and funds can be made available for their publication. It is believed that these county reports will be quite valuable, not only to the different agencies working with the farmers, but also be of direct value in the hands of farmers themselves. They should be very useful, too, for teachers of agriculture and others who are engaged in the building up of a better and more wholesome life in the county.

The main soil fertility investigations being conducted by the Division are at the Buncombe, Iredell, Central, Granville, Edgecombe, Washington, and Pender Branch Station farms. Supplementing these main investigations are experiments on different types of soil in different parts of the State. These latter are being carried out on the land of farmers who have been kind enough to set aside a small section of their farm for this work. These latter experiments are located with reference to the types of soil that are most important in the section. An effort is always made to obtain the cooperation of farmers who are specially interested and the soil of whose farms is of the particular type on which it has been previously decided that work should be conducted.

At the present time, this latter work is being carried on as follows:

In the Mountains—

On Toxaway silty loam at Andrews
On Porter's loam at Swannanoa
On Toxaway loam at Swannanoa

Piedmont Section—

On Cecil clay loam at Statesville
On Cecil sandy loam at Gastonia
On Cecil sandy loam at Winston
On Mecklenburg clay loam at Concord
On Durham sandy loam at Oxford
On Durham sandy loam at Franklinton
On Durham sandy loam at Louisburg

Coastal Plain Section—

On Norfolk fine sandy loam at Rocky Mount
On Portsmouth fine sandy loam at Pantego
On Portsmouth fine sandy loam at Willard

In addition to this, similar work is to be conducted on the farms connected with eleven Farm-Life Schools of the State. This latter work is not only valuable in determining the plant-food needed for the type of soil on which the Farm-Life Schools are located, but, it also places in the hands of the teacher of agriculture in these schools vitalizing materials to use with his classes in agriculture.

At the Washington Branch Station Farm.—The main efforts at this farm have been directed during the year to a study of the effects of different fertilizer combinations with and without the use of lime. At the present time, the addition of phosphoric acid and potash has shown but little if any benefit when used alone or in combination. The use of lime has been shown to be the chief need at present. Amounts up to two or three tons per acre have resulted in increased crop yields.

At this farm, experiments have been started to determine the relative value of hydrated lime, ground limestone, and marl for use on the soil. The quantities used have been equivalent to one, two, three, and four tons of calcium carbonate per acre, once every three years. As only one year's results have thus far been secured, it is not possible to say at this time what will be the conclusions from them. Indications thus far are that more than one ton of lime per acre is needed. Analyses of these and other "black land" soils in the Wenona section have shown, too, that much more lime is required than one ton to neutralize or destroy the sourness contained in the seven inches of surface soil.

At the Pender Farm.—Fertilizer experiments are being conducted at this farm with corn, oats and vetch, and cotton, in a three-year rotation, with a cover crop always on the land. It has been found that nitrogen is the constituent needed most by the soil at the present time. Phosphoric acid and nitrogen used in combination have given more increase in yield of crops than has potash and nitrogen. The use of lime has shown up well, especially has this been the case with soybeans. Thus far in the study of the relative value of finely ground phosphate rock, basic slag and acid phosphate as carriers of phosphoric acid, the acid phosphate has, up to this time, shown to advantage.

At the Edgecombe Farm.—At this farm the main part of the soil fertility studies are in Fields A, B, and C, where a three-year rotation consisting of corn, cotton, and peanuts, with leguminous cover crops every year is used. These experiments, among many other things, have shown nitrogen and potash to be the two constituents of first importance to be applied for the most profitable growth of crops. It should be stated, however, that with the use of larger amounts of nitrogen and potash than is commonly applied the use of phosphoric acid begins to show up. Results on the whole at this farm indicate that eastern farmers are not always using the best combinations and the best amounts of fertilizer mixtures per acre. For the best paying results, more nitrogen and potash should be used than is ordinarily applied, while the phosphoric acid in many cases may be slightly reduced.

In studies that have been carried on at this farm to determine the relative value of different carriers of nitrogen for different crops, nitrate of soda has been shown to be the most effective, with sulphate of ammonia showing up second in efficiency.

At the Iredell Farm.—As indicated in previous reports, the experiments at this farm have shown that the soils are mainly deficient in

nitrogen and phosphoric acid. Lime is giving very good results and the yields of crops indicate that where more organic matter is incorporated with the soil than is ordinarily contained by the soils in the section, in which the farm is located, that still better results may be anticipated. In the rotation experiments which are in operation, the results show marked increase of the non-leguminous crops by the addition of legumes to the rotation.

In the study of the value of different forms of nitrogen carriers, the mineral sources—nitrate of soda and sulphate of ammonia—have shown to have greater efficiency than the organic sources. There does not seem to be any marked residual effect resulting where organic sources were used.

In the regular fertilizer experiments, finely ground phosphate rock has not shown to be as economical as a carrier of phosphoric acid, as acid phosphate, notwithstanding the fact that the price of acid phosphate has materially advanced during the past year or two.

At the Buncombe Farm.—In the regular fertilizer experiments at this farm, both on uplands and bottomland soils, it has been shown that phosphoric acid, nitrogen, and lime are the main controlling factors for better crop yields.

In the finely ground phosphate rock tests on bottom soils where the comparison of this is made with acid phosphate with lime, with stable manure, and with legumes, the acid phosphate is giving greater and more profitable crop yields. The use of lime is beginning to show up on the soils on this farm to much better advantage generally than it did during the first few years of the tests, particularly is this so with the bottom soils.

At the Central Farm.—Nitrogen and phosphoric acid have been shown to be the main controlling constituents in crop production on the soil of this farm. Lime is essential for success in the growth of legumes and its use is necessary in order to increase the organic matter condition in the soils of this section by the growth of such crops as cowpeas, soybeans, and suitable clovers. The experiments here have demonstrated fully that with a short rotation of cotton and corn with little or no cover crops, it is not possible to build up the producing power of the soil. During the year, the experiments have been slightly adjusted for the purpose of studying what effects the different fertilizer combinations will have when at least one good cover crop is turned into the soil each year. This information secured from year to year compared with that which has been secured from the same plots with practically no cover crop, should afford very valuable information with reference to the value of legumes in the rotation. The tests in this connection that all of the different fertilizer combinations used hereafter are to be run with and without lime as well to determine the effect of turning under of a good cover crop annually.

At the Granville Farm.—In the study of the value of different sources of nitrogen, phosphoric acid, and potash, and combinations of these for

tobacco, results thus far secured indicate that the organic sources of nitrogen are best. Dried blood is probably best with cottonseed meal next of the more common nitrogenous carriers. When mixed with proper proportions of phosphoric acid and potash, sulphate of potash produces a better quality of tobacco than does muriate of potash. The muriate, however, seems to make a larger leaf, or one with a larger spread. Acid phosphate has given better results as a carrier of phosphoric acid for tobacco than has either bone meal or basic slag.

In the study of the best proportions of potash to use for tobacco, where the quantity used ranged from 12 to 80 pounds per acre both from sulphate and muriate of potash, the results thus far secured show that even a small amount as 12 pounds of potash to the acre gives a considerable increase in the yield and improvement in quality. The quality and yield of the tobacco both improve rapidly as the quantity of potash is increased to 50 to 70 pounds per acre. There was a slight improvement when the quantity was increased above 60 pounds, but there was not so much difference as was observed in increasing the amount up to 60 pounds per acre.

The field experiments in the study of the value of tobacco stems and stalks for fertilizing tobacco have indicated that good tobacco can be grown by the use of these, when they are not used at a rate heavier than 2,500 pounds per acre, supplemented with a little phosphoric acid and potash, if native or bright tobacco stems are used; and by phosphoric acid and nitrogen when burley stems and stalks are applied. Good results, too, have been obtained by the use of stable manure and wood ashes with 200 to 300 pounds of acid phosphate per acre.

At the Reidsville Farm.—Tobacco experiments have been conducted on this farm to determine the best and most profitable combinations and amounts of fertilizers to be used per acre. These experiments have been carried on for a number of years. They have shown the profitableness of liberal applications of fertilizers of the right kind for this crop. Generally, it has been found that a complete fertilizer should be used, that is, one containing phosphoric acid, ammonia, and potash. These materials are important in about the order given. On the thin "light" soils the relative need for potash is greater than on the stiffer tobacco soils. In respect to ammonia, the requirements are more variable, they depending upon how the soil has been treated in the years immediately preceding the growth of tobacco, but the lighter soils generally need more ammonia than do the stiffer soils to give best returns. Averaging the experiments in an approximate way for practical purposes, it is recommended that for thin white land 800 to 1,000 pounds per acre of a fertilizer containing 8 per cent available phosphoric acid, 4 per cent of ammonia and 3 per cent of potash be sued. On the stiffer, mulatto type of soils, 600 to 800 pounds of 8–3–3 or even 8–2–2 may be expected to give good results under average conditions. But even on these stiffer

soils, it is probable that more ammonia would in most cases be found profitable.

In the study of the residual effect of fertilizers on small grains, generally wheat and then grass following after tobacco with no additional fertilizer, the residual effect of phosphates was dominant and very important; or, stating it negatively, where acid phosphate was not used but little residual effect was noticeable in the growth of the crop, no matter how much potash or ammonia had been applied to the previous crop of tobacco. However, on every plot where phosphate was applied the increase in yield was striking and lasted throughout the four-year course of the rotation. Even when used with phosphate, the residual effect of materials carrying ammonia was not generally important for more than one year. The use of potash alone or combined with ammonia only had almost no residual effect. The results of these experiments indicate that phosphoric acid is of fundamental importance in building up the fertility of these soils.

NEW WORK AT THE FARMS

A new experiment has been started at the Pender Farm to study the relative value of soft phosphate rock as compared with acid phosphate and basic slag as a carrier of phosphoric acid. This same experiment is being repeated at the Buncombe Farm. At the Edgecombe Farm, an experiment was put out this fall in cooperation with the Office of Forage Crop Investigations, Washington, D. C., to test the relative resistance to winter-killing of crimson clover seed obtained from different sources. The data from this test should be valuable in determining what will probably be our best sources from which to secure seed of this legume for planting purposes.

COTTON BREEDING INVESTIGATIONS

Considerable effort has been given during the year to the project designed to study the inheritance and association of the economic qualities of the cotton plants. Of 72 selected strains grown in 1917, thirty of the most distinct were planted again during the past spring. Seed of several of these strains, not planted this season, have been reserved for planting next season. The strains isolated during the past four years are now of a uniform type and have transmitted their qualities during the past two years. In individual strains the values for size of boll, length of staple, per cent of lint and height of plant have fluctuated from season to season, but the strains have held the same relation to each other. For instance, all of the strains grew taller in 1917 than in 1918, but in both of these years the strains held their same relative position. Although the 30 specially selected strains have been self-pollinated during the past five years, there has been no perceptible reduction in the vigor of the plants. During the past two years grown under

the same conditions, the lowest yielding strain has averaged 81.8 grams of seed cotton per plant, while the highest yielding strain has averaged 179.6 grams per plant. Sufficient data has thus far been collected to make publication on the main part of this project. Further work will, in the main, deal with the behavior of the different qualities when strains are crossed.

COOPERATIVE STUDY OF "PLACE EFFECT" UPON QUALITIES OF COTTON

This work is being carried on for the purpose of making a comparison of cotton plants from Mississippi and North Carolina-grown seed of the same strain to see what effect the change of seed will have upon the growth and quality of the plant. This work is being conducted in cooperation with the Mississippi Agricultural Experiment Station. The original seed for starting the work came from a self-fertilized plant in a uniform row of the plant-to-row breeding patch at West Raleigh in 1914. One-half of the seed from this plant was planted in Mississippi and the other half grown at West Raleigh. Each year following, except in 1916, seed have been exchanged for comparison with locality grown seed. In the North Carolina comparisons, there has been very little difference between the earliness of plants grown from seed from the two localities. During the past two years, the Mississippi seed have produced slightly taller stalks. The North Carolina seed have produced the larger yields in the two comparisons made at West Raleigh.

WORK IN THE IMPROVEMENT OF CROPS AT THE EXPERIMENTAL FARMS

At the Mountain Farm.—On this farm corn is being selected to improve the uniformity and yield of a strain of Biggs' Seven-ear. With selections made during the past two years, the percentage of barren stalks has been reduced and a much more uniform strain has been isolated. The corn has been selected for a two-eared stalk rather than for the larger number found on the original strain of this variety. The specially selected strain is to be compared with a few of the other best varieties during the coming season.

At the Piedmont Farm.—On this farm selections are being made of corn, cotton, wheat and oats, and rye.

The strain of Weekley's Improved corn grown on the farm has been selected by the plant-to-row method. Last year a sufficient amount of the highest yielding strain of this variety was turned over to the superintendent of the farm for planting the general crop. In the meantime the ear-to-row work has been continued to further improve the strain.

Three years ago a portion of the seed from strain No. 29 from King's variety of cotton selected at the Central Farm at West Raleigh was transferred to the Piedmont Farm for increase there. This strain has proved to be well adapted to this latter section. Sufficient selections are made each year from this strain to grow a seed patch of one acre.

The selections are ginned on a hand gin in order to retain the purity of the strain.

The results of the wheat improvement work that has been carried on at this farm have been unusually encouraging. Last season, the number of selected strains of Leap's Prolific were reduced to ten. During the fall these ten strains were planted in rod rows and were duplicated fifty times. After each series of the ten selections, one check row was planted to the best obtainable pedigreed Leap's Prolific seed. When compared with the ordinary commercial seed of Leap's Prolific in 1917, the improved strain yielded 8.4 bushels more per acre than the commercial seed.

In the improvement work with oats, selections have been made to increase the yield and resistance to cold of the Appler variety. Last season the selected strains of oats were reduced to four, as these represented the highest yielding ones in the test of that year. They were planted again in the fall of that year to further test out their yielding and cold-resistance powers. They were compared with the ordinary commercial seed and with the best pedigreed strain of Appler oats. The selected strains showed much more resistance to cold than did the best of the commercial seeds of the same variety. When the yields were taken the best selected strain (No. 12) had yielded 11.3 bushels of seed per acre more than the check.

Six selected strains of Abruzzi rye were also compared with the best pedigreed seed of the same variety that could be had on the market. In order to make a fair comparison and at the same time increase the good strains, the selected strains and checks were grown in rod rows and were repeated fifty times. In this comparison, three of the selections outyielded the checks. The best selected strain yielded 39 pounds per acre more than did the best seed obtainable on the market. This increase would be considered rather small to be counted as an increase had not the pedigreed commercial strain lead the test the previous year.

At the Central Farm.—Field selection work is being continued with cotton, corn, wheat, Abruzzi rye and soybeans at this farm.

In the cotton work, selections have been continued with strain No. 29. A seed patch is planted from selected stalks each year. This seed patch furnishes seed for the general crop as well as for the seed patch the following year. Each year the seed cotton from the seed patch is ginned with a small gin in order to keep the seed pure. Last season an early selection from Mexican Big Boll was brought in to compare with strain No. 29. The strain from this latter variety because of its longer staple and much larger boll is showing up to very good advantage.

Similar work to that done with cotton is being carried on with Cook's Prolific corn, and a special effort is being made to improve the yielding power and uniformity of this strain of corn grown on this farm. Much encouragement has thus far been secured in this direction.

In the wheat improvement work, selection No. 12 from Leap's Prolific variety has continued to lead all others. When compared with the

best pedigreed seed available in rod rows duplicated fifty times, strain No. 12 has given slightly larger yields than any others, notwithstanding the fact that it labored under slight disadvantages. It is interesting to note in this connection, that the four selected strains of Leap's Prolific grown his year yielded the same relative rank as they did in the tests of last year.

The selected strains of Abruzzi rye were reduced during the past year to the four very best. These were compared with the best strains of this varity that could be had. Strain No. 27, which has been the leading one in previous years, yielded 59.9 pounds per acre more than did the checks.

Selections are being made to increase the yield and oil content of the Mammoth Yellow variety of soybeans, as well as for increasing the yielding powers of the Haberlandt and Virginia varieties. Work with the Mammoth Yellow variety was started in the fall of 1916 when seed from 150 selected plants were saved from a field near Tarboro. The oil content was determined from the seed of each plant and progeny rows were grown in 1917. The original selections ranged from 15.6 to 22 per cent of oil in the seed. The progeny rows were harvested separately and again the seed were analyzed for oil content. The range or percentage of oil in the seed of the progeny rows was not quite so great as that of the parents. Only a few of the high oil parents produced progeny with high oil content and some of the highest yielding rows were low in oil content. Selections were made from strains which had shown the highest content of both parent and offspring and one of the highest yielding rows with low oil content was retained for comparison in 1918.

Prolific strains of Haberlandt and Virginia have been isolated and are now being increased. Both of these have proven to be greatly superior to the original strain grown on the farm. One slightly later and more prolific strain of Haberlandt has been isolated with the view of increasing it for the mountain section of the State.

At the Coastal Plain Farm.—On this farm in Edgecombe County, cotton and corn are being used for the selection work.

The work with corn, as with other crops, has been handicapped on account of the lack of a proper place to store and handle the selections as is afforded at the Mountain and Piedmont farms.

The Mexican Big Boll cotton on this farm has been selected to increase the yeilding power, earliness and uniformity of the plants. A strain, isolated two years ago, has been increased so as to furnish enough seed for planting the entire general crop this past season. Other selections are being made in order to further improve this strain.

At the Granville Farm.—In the study of varieties of tobacco on this farm, so far there has not been very decided differences in the yield in a number of the so-called varieties that have been tested. All of them seem to be more or less closely related to the Orinoco type. There has been, however, a considerable difference between the poorer varieties and the

best ones, the latter averaging from 100 to 200 pounds per acre more than the former. The Adcock variety is one of the best for wrappers, but for priming the Warne gives as good results as the Adcock and perhaps is a slightly heavier yielder. The former grows with shorter internodes than does the Adcock. When tobacco is harvested by cutting the main objection to the Warne type is that it does not ripen up close to the stalk, consequently there are a good many green butts.

RESULTS OF TESTS WITH VARIETIES OF FIELD CROPS

During the past year in the variety tests on the different farms the number of varieties studied have been reduced to those which have previously shown up to have superior value and to those that would appear to possess these qualities.

Among the new varieties tests during the year were Rosen rye, Liberty cotton and Jones' Climax wheat. Rosen rye, which has been extensively advertised as better than Abruzzi rye, has generally proven too late for Piedmont and eastern North Carolina conditions. It has not been found to furnish as much early grazing as does the Abruzzi rye and does not make sufficiently early growth for turning under early in the spring. In the mountain section, it produces a larger quantity of seed, and appears to have considerable promise for the production of seed in this section of the State.

The Liberty variety of cotton has a very small boll, produces a medium yield, and is unusually late for the size of its boll. The trials this year would not justify us in recommending this variety for growth under North Carolina conditions.

The tests of Jones' Climax wheat at Statesville and at West Raleigh did not show this variety as specially adapted for these sections.

At the Mountain Farm.—During the past season varieties of corn, cowpeas, soybeans, wheat, spring oats, and rye were tested at this farm. Below are given a list of the varieties of these that have shown up, on an average, to best advantages for planting under the conditions as represented by this farm:

Corn

First Generation Cross No. 182	Parker's Prolific
Southern Beauty	Latham's Double
Weekley's Improved	

Wheat

Leap's Prolific	Fulcaster
Fultz	

Spring Oats

Appler	Fulghum
Red Rust Proof	Burt
Virginia Turf	

Soybeans

Haberlandt	Medium Yellow
Austin	Wilson Black
Virginia	Black Eyebrow

Cowpeas

Taylor	Monetta
Early Red	Groit

At the Piedmont Farm.—On this farm the variety tests of corn, soybeans, cowpeas, wheat, and oats have shown the following to be the leading varieties:

Corn

Southern Beauty	Jarvis' Golden Prolific
Biggs' Seven Ear	Grampian (Goodman's Prolific)
First Generation Cross No. 182	Cocke's Prolific

Soybeans

Mammoth Yellow	Tarheel Black
Haberlandt	Virginia

Cowpeas

Groit	Black
Early Red	Two-crop Clay

Wheat

Purple Straw	Fultz
Leap's Prolific	Fulcaster

Oats

Appler	Fulghum
Red Rust Proof	Burt
Virginia Turf	

At the Central Farm.—The testing on this farm has shown the following to be the most satisfactory yielders of varieties thus far tested:

Corn

Biggs' Seven-ear	First Generation Cross No. 182
Southern Beauty	Jarvis' Golden
Parker's Prolific	

Soybeans

Mammoth Yellow	Tokyo
Mammoth Brown	Virginia
Tarheel Black	Haberlandt

Cowpeas

Groit	Red Ripper
Whippoorwill	Early Red
New Era	Whippoorwill X New Era

Wheat

Purple Straw	Fultz
Leap's Prolific	Fulcaster

Rye

Abruzzi	Common

At the Coastal Plain Farm.—As a result of several years testing on the farm located in Edgecombe County, it has been found that the following are the leading varieties of corn, soybeans, and cowpeas for that section of the State:

Corn

Biggs' Seven-Ear	Jarvis' Golden Prolific
Latham's Double	Williamson
Gerrick's Prolific	

Soybeans

Mammoth Yellow	Wilson Black
Virginia	Haberlandt
Tarheel Black	

Cowpeas

Brabham	Black
Groit	Monetta
Early Red	Whippoorwill

At the Tobacco Farm.—In the test of seventeen varieties of corn during four years on this farm in Granville, the following is about the order they have shown up to be as yielders of shelled corn per acre:

Biggs' Seven-ear	Cocke's Prolific
Deaton's Two-ear	Eureka
Latham's Double	

At the Black Land Farm.—As a result of three years tests with corn in which twenty-three varieties have been grown, the following have shown up to be the leading ones at this farm in about the following order:

Latham's Double	Tom Green
Horse-Tooth	Wannamaker

At the Pender Farm.—As a result of two years tests, in which eight varieties of soybeans and cowpeas each have been tested, the following have shown up, in about the order given, to be the most promising ones for that section of the State:

Soybeans

Mammoth Yellow	Wilson Black
Virginia	Tarheel Black

Cowpeas

Groit	Two Crop Clay
Whippoorwill	Early Red

MISCELLANEOUS TESTS WITH TOBACCO

A study has been made at the Granville Farm to determine if by more intensive fertilization and closer planting the yield of tobacco can be increased without injuring its quality. The evidence so far from these experiments seems to be conclusive that in a great many sections of the old tobacco belt, growers do not plant enough tobacco on the land. Five thousand to 5,500 plants seem to be about the right number for best results, while a great many farmers do not plant more than 3,500 to 4,000 per acre.

In the study of the relative value of priming and cutting tobacco at the Granville Farm it has been found that a gain of 240 pounds per acre was obtained by priming the leaves instead of cutting the stalks, which is commonly practiced. This increase has been equalled in value to more than $49.00 per acre. It is believed that the results of this ex-

periment would be of value to the old tobacco belt, particularly as the new tobacco belt farmers all prime their tobacco, anyway.

It has been brought out in the fertilizer experiments conducted at Reidsville that by increasing the ammonia content of the fertilizers used, there has been observed a great susceptibility to leaf spot and other diseases effecting the tissues, such as rot and wild fire. Potash appears to increase the resistance of the tissues to these diseases and makes a heavier bodied leaf.

Respectfully submitted,

C. B. Williams,

Chief Division of Agronomy.

REPORT OF THE DIVISION OF CHEMISTRY

To the Director:

The greater part of the work of this Division during the year has been the compilation of the results of previous years. Some very interesting and satisfactory results have been obtained with the assistance of Drs. Williams, Miller, and Dobbins, and Mr. Fetzer, of the staff of the Chemistry Department of the College, who began work with the Station on March 1st.

Four articles have already been published for the year, namely:

"Methods for Approximating the Relative Toxicity of Cottonseed Products" *Journal of Biological Chemistry*, October, 1917. F. E. CARRUTH.

"Iron as an Antidote to Cottonseed Meal Injury," *Journal of Biological Chemistry*, November, 1917. W. A. WITHERS and F. E. CARRUTH.

"Gossypol the Toxic Substance in Cottonseed," *Journal of Agricultural Research*, January 14, 1918. W. A. WITHERS and F. E. CARRUTH.

"Contributions to the Chemistry of Gossypol," *Journal of the American Chemical Society*, April, 1918. F. E. CARRUTH.

There is in manuscript form, ready to submit for publication, another article to be entitled "Comparative Toxicity of Cottonseed Products," *Journal of Agricultural Research*, September 2, 1918. W. A. WITHERS and F. E. CARRUTH.

A brief summary of the principal conclusions of these articles is shown as follows:

(1) We have devised a method for making a qualitative test of gossypol.

(2) We have devised a method for determining quantitatively the amount of gossypol in cottonseed meal, including the unchanged gossypol and the gossypol which has become fixed.

(3) Iron salts, although unable to prevent cottonseed meal injury, was shown to have a beneficial effect in the way of enabling animals to eat larger quantities of meal, and in many cases death has been postponed or averted.

(4) This control to some extent by iron salts of the toxic factor indicates that there is little foundation for the theory of others that cottonseed meal injury is due to lack of vitamines or mineral matter.

(5) Further evidence in support of our previous conclusions that gossypol is the toxic substance in cottonseed is found in the fact that

a. Raw kernels are harmful to rats, and that the harmful substance is removed by ether, giving a toxic extract.

b. Gossypol itself has been found toxic to pigs.

c. The residue left after extraction of the kernels with ether is nontoxic.

(6) We have found that cooking the kernels renders them much more toxic on account of the diminution of the amount of gossypol and of its change to a much more difficult soluble form.

(7) We have found a considerable variation in varians animals with reference to the toxic effect of cottonseed products, the rats and fowls being able to withstand very much larger relative amounts of cottonseed meal for longer periods. Pigs and rabbits are very susceptible.

(8) We have been unable in the case of pigs to overcome the toxic effect of cottonseed meal by adding large amounts of vitamines and minerals.

RESULTS SECURED

With the assistance of Dr. Williams, Dr. Miller, Dr. Dobbins, and Mr. Fetzer, we have obtained, among others, the following results:

(1) We have collected samples of cottonseed meal from various mills in the State and found considerable variation in the amount of gossypol, in the amount of D gossypol and in the sum of these two substances.

(2) It appears to us that a considerable variation in this substance is due to the method of manufacturers, but it appears to us also that there must be a difference in the seeds as well.

(3) Our experiments indicate the possibility of producing a meal for commercial purposes of very much less toxicity than the meal usually found on the market. This toxicity may be reduced so low as to be inappreciable. We should like to make further tests along this line with animals.

(4) We have made further study of the difficultly soluble gossypol in cottonseed meal and we have indications that the main change in the gossypol is due to its union with the proteid matter of the meal and its greater insolubility on this account.

(5) Some progress has been made in the knowledge of the chemistry of gossypol.

I feel considerable, and I hope not improper, pride in presenting a summary of this work. We feel satisfied that gossypol is the toxic substance in cotton seed, and that its removal will render cottonseed products nontoxic. We think that from the scientific standpoint this is a considerable achievement. From a practical standpoint we have indications as to the practicability of a method for the removal to a large extent of gossypol, thus rendering it a safe protein feed.

We cannot accept the vitamine theory of Rommel and Vedder, of the United States Department of Agriculture, or the conclusions of Misses Richardson and Green, of Texas, and we are of the opinion that Osborne and Mendel, of Yale, are in error in some of their conclusions. We think that our work will stand and its standing contrary to the conclusions of these excellent and experienced workers is, in our opinion, quite an achievement.

Respectfully submitted,

W. A. Withers,
Chemist, Experiment Station.

REPORT OF ANIMAL INDUSTRY DIVISION

To the Director:

Heretofore I have, in my Annual Report, reviewed in more or less detail the outstanding phases of animal industry work. This year, however, I intend to give only mere statements of projects. If you desire a full report of any particular phase, it will be little trouble for me to place it in your hands, upon request, as the greater part of the work is summarized up to date.

BEEF CATTLE AND SHEEP

R. S. Curtis, *in Charge*

Assisted by Earl Hostetler, F. T. Peden, J. W. Sloss, J. B. Peery, George Evans, and W. R. Radford

Experimental Work:

1. The Relative Value of Velvet Bean and Cottonseed Meal as a Feed for Fattening Beef Cattle. (Central Experimental Farm.)
2. The Relative Value of Soybean and Cottonseed Meal for Fattening Beef Cattle. (Central Experimental Farm.)
3. An Investigation to Determine Whether or Not Cottonseed Meal Influences Unfavorable Breeding Qualities of Animals. (Central Experimental Farm.)
4. The Relative Value of Peanut and Cottonseed Meal for Fattening Beef Cattle. (Edgecombe Test Farm.)
5. Determining the Cost of Wintering Feeders and Effect of Different Methods of Wintering Upon the Subsequent Gains Upon Pasture. (Iredell Test Farm.)
6. Determining the Cost of Wintering Stockers and Feeders Under Different Methods and the Effect Upon the Cattle Throughout the Subsequent Summer Period. (T. L. Gwyn Farm, Haywood County.)
7. Determining the Best Method of Wintering Breeding Cows and Growing Mature Calves for Breeding Purposes. (Cotton Valley Farm, Tarboro.)
8. Studies in Milk Sickness or Trembles. (Central Experimental Farm and Iredell Test Farm.)
9. Determining the Effect of Heavy Rations of Cottonseed Meal on the Health and Reproductive Abilities of Breeding Ewes. (Central Experimental Farm.)
10. Determining the Cost and Best Methods of Feeding Breeding Ewes During Both Winter and Summer. (Iredell Test Farm.)
11. Determining the Best Methods of Growing and Feeding Sheep in the Mountains of North Carolina Both Winter and Summer Seasons. Spruce Pine Farm.)

DAIRY EXPERIMENTAL WORK

Stanley Combs, *in Charge*

On March 18, 1918, Mr. W. H. Eaton, who had charge of the Dairy Experimental Work for about three years, resigned to go to Alabama to accept a more lucrative position. Mr. Stanley Combs, who, up to that time, had been associated with the Dairy Field Office, was appointed to fill this vacancy.

Since Mr. Combs assumed the direction of the Dairy Experimental Work he has devoted the most of his time to attending to the business

end of the Pender dairy herd, trying to inject better care and business principles into its management. He has succeeded very well in doing this, too, as the herd is now more than paying its way. Our object, of course, is not to make money out of the Pender dairy herd, but it is there for investigational purposes. However, we do expect it to pay its way and secure valuable investigational results in addition. The herd is being built up to a 30-cow dairy. At the present time there are altogether 44 animals in the herd, many of them being calves and other young stuff.

The investigational projects under way at the present time are:

1. To Determine the Relative Value of Cottonseed Meal, Soybean Meal, and Velvet Bean Meal for Raising Dairy Calves. (Pender Test Farm.)
2. Determining the Cost of Raising Dairy Heifer Calves. (Pender Test Farm.)
3. Determining the Cost of Milk Production. (Greensboro Neighborhood. This work is now closed and the results are being summarized.)
4. Determining Whether It is Possible to Remove the Onion Flavor From Milk and Butter. (Pender Test Farm and Central Experimental Farm.)
5. The Effect of Feeding a High Ration of Cottonseed Meal Upon the Breeding Quality of Dairy Animals. (Central Experimental Farm.)
6. Just as soon as Mr. Combs gets a good grasp of the business ends of the Pender dairy herd, he will launch into investigational problems connected with feeding milking cows.

POULTRY EXPERIMENTAL WORK

Dr. B. F. Kaupp, *in Charge.*
Assisted by J. E. Ivey

1. Pathological Studies of Roup, Bone Diseases, Limberneck, Diseases of the Oviduct and Ovary, Abdominal Diseases, Tumors, etc. (Central Experimental Farm.)
2. Anatomy, Physiology and Histology of the Domestic Fowl. (Central Experimental Farm.)

> Dr. Kaupp has recently written a book on this question which is a contribution to scientific literature. The work was all done in his laboratory.

3. Mineral Requirements of Growing Chicks. (Central Experimental Farm.)
4. The Value of Velvet Bean Meal for Feeding Poultry. (Central Experimental Farm.)
5. The Value of Peanut Meal as a Feed for Poultry. (Edgecombe Test Farm.)
6. Breeding for Egg Production. (Central Experimental Farm.)
7. Dry Lot Feeding of Growing Chickens Against Range Conditions. (Iredell Test Farm.)
8. Physical Measurements Correlated With Egg Production. (Central Experimental Farm.)
9. Hen Culling Records Based on Physical Indications. (Central Experimental Farm.)
10. Buttermilk Compared With Meat Meal in a Ration for Poultry. (Iredell Test Farm.)
11. Experiments to Determine the Best Method of Shipping and Packing Eggs. (Central Experimental Farm.)
12. Determining the Place of Cottonseed Meal in a Ration for Hens. (Central Experimental Farm.)

13. Fattening and Shipping Broilers and Fowls. (Central Experimental Farm.)
14. Experiments to Determine Factors Which Control Fertility in Fowls. (Central Experimental Farm.)
15. Factors Which Determine Chick Mortality. (Central Experimental Farm.)
16. A Study of the Distribution of Blackhead in Turkeys. (Central Experimental Farm.)
17. The Value of Buttermilk Cheese and Buttermilk as a Feed for Raising Young Chicks. (Central Experimental Farm.)
18. Studies in Gathering, Curing, and Shipping Feathers. (Central Experimental Farm.)
19. Studies in Protein Requirements of Laying Hens and Growing Chicks. (Central Experimental Farm.)
20. Mendelian Studies in Breeding White Leghorns, Barred Rocks, and Rhode Island Reds. (Central Experimental Farm.)

SWINE EXPERIMENTAL WORK

DAN T. GRAY, *in Charge*
Assisted by EARL HOSTETLER

1. To Determine the Value of Soybean Pasture and Peanut Pasture When Fed Alone and When Fed With a Partial Ration of Corn for Fattening Hogs (Edgecombe Test Farm.)
2. To Determine the Value of Peanut Gleanings After the Peanuts Are Removed for Market. (Edgecombe Test Farm and Cotton Valley Farm.)
3. To Determine the Vale of Bur Clover as a Grazing Crop for Hogs. (Edgecombe Test Farm and Pender Test Farm.)
4. Determining the Value of Permanent Pastures for Hog Grazing. (Edgecombe Test Farm and Pender Test Farm.)
5. To Determine the Cost of Raising Pigs to Weaning Time. (Edgecombe Test Farm and Iredell Test Farm.)
6. To Determine at What Time Hogs Should Be Turned on to a Soybean Pasture for Best Results. (Cotton Valley Farm.)
7. To Determine the Relative Value of Soybean and Peanut Pastures When Fed in Conjunction With a Half Ration of Grain. (Pender Test Farm.)
8. Studies Relating to Methods of Curing Meats. (Central Experimental Farm and Pender Test Farm.)
9. The Effect of Grazing Crops Upon the Bodies of Hogs and Determining the Value of Various Concentrated Feeds for Hardening the Bodies of Hogs After Being Rendered Soft. (Central Experimental Farm and Edgecombe Test Farm and Pender Test Farm.)
10. To Determine the Value of Soybean Meal, Velvet Bean Meal, and Peanut Meal in a Hog's Ration. (Central Experimental Farm and Pender Test Farm.)

HORSE AND MULE WORK

On account of the fact that the Division has no one in charge of the Horse and Mule Work, little is being done. Only one project is being studied:

1. To Determine the Place of Cottonseed Meal in a Ration for Horses and Mules. (Edgecombe Test Farm, Pender Test Farm, and Iredell Test Farm.)

LETTERS WRITTEN AND NUMBER OF MEETINGS ATTENDED

This year the members of the Animal Industry Division have answered 22,629 personal letters from farmers in this and other states.

The following summary is a close estimate of the number of meetings the members of this Division have attended and the number of people met in public meetings:

Office	Farmers' Institutes	Dairy Schools	Other Meetings	Total Attendance
Administrative			4	425
Beef Cattle and Sheep	28		192	16,500
Poultry Clubs			194	14,514
Poultry Investigations			5	475
Dairy Extension	10	41		3,090
*Creamery meetings			11	433
*Other meetings			186	13,374
Swine Extension and Pig Clubs	32		486	26,911
Totals	70	41	1,078	75,722

*Under the head of Dairy Schools.

The above statement does not include the number of people met by the members of the Division on personal visits upon farms; neither does it include the number of people met at the two largest agricultural meetings of the state, namely, the Annual Live Stock Meeting and the Farmers' Round-up Institute at Raleigh.

Respectfully submitted,

Dan T. Gray,

Chief, Animal Industry Division.

REPORT OF THE DIVISION OF ENTOMOLOGY

To the Director:

I herewith present report upon the several projects of Investigational Work which are being conducted by this Division, covering the year from June 30, 1917, to June 30, 1918. In the course of discussion of the several projects, several have been mentioned in which it is desirable that an assistant be especially assigned, particularly as follows:

An assistant assigned to State Insect Survey Work.

An assistant assigned to study of Insects in Relation to Health and Comfort of Man.

INVESTIGATIONAL WORK

The Investigational projects are as follows:

1. *Pecan insects.*—A study of the insects which attack the pecan, with study of remedies for those that are seriously destructive.

2. *Corn stalk-borer.*—A study of the life-history, habits, generations, etc., of this pest, with study of methods for control.

3. *Potato spraying.*—Tests of mixtures and times of application to devise the most practicable and most profitable spraying schedule to control potato beetle, and at same time secure highest yield.

4. *Soap and water remedy for aphids.*—Tests of this simple home-made preparation, in place of more complicated or less available materials, often recommended.

5. *Insect survey.*—A study of the insect life of the State, to determine the distribution within the State of injurious, beneficial, and other insects.

6. *Field studies of black corn weevil.*—Observations to throw light on methods of farm practice which may lessen weevil damage to corn, especially in the coastal region.

7. *Mosquitoes and flies.*—Studies and observations of the control work done by the Public Health Service in and near shipyards and camps, as a basis for similar work by State or local authorities in time of peace.

8. *Cabbage dusting to control worms.*—To revise knowledge previously gained on this subject, by use of newer materials and improved equipment.

Taking up these several projects in the order listed:

1. *Pecan Insects*

The work on this project is done by Mr. R. W. Leiby, Assistant Entomologist. While studies and observations are made in many private orchards, the chief sources for securing data are the pecan orchards on the Branch Station Farms in Pender and Edgecombe counties. Careful studies have been continued upon twig girdler, case-bearer, trunk-borer, flat-head and round-head borers, leaf-eating caterpillars, shuck-weevils,

nut-weevils, etc. Tests for control of several of these have been made during the year, while observations upon the habits and life-histories are always valuable as indicating the exact time for applying remedies so as to secure best protection.

2. *Corn Stalk-Borer*

The work on this project is chiefly by Mr. Leiby, with supplementary work by F. Sherman, Entomologist. The chief sources of information are the corn fields at the Pender and Edgecombe farms, more especially the latter. Continued observations support conclusions alluded to in previous reports, that there are two main destructive broods of this borer, and that, consequently, late planted corn is subject to much less injury than that which is planted earlier. Other observations are in progress to show the effect of certain simple field operations.

3. *Potato Spraying.*

Conducted by Mr. Leiby at the Mountain Branch Station in Buncombe County, supplemented in 1918 by a test in the coastal region at New Bern.

The fifth year's operations on this project in the mountains is under way in 1918, and, in order to emphasize the importance of potato spraying as a war measure, a corroborative test is being made in 1918 in the vicinity of New Bern. We feel that the data secured in each of these years has proven conclusively that proper spraying of Irish potatoes is highly profitable in the mountains, and certainly, when these results are combined into a five-years average, it should be a safe criterion to the results that can be reasonably expected from the practice.

4. *Soap and Water Remedy for Aphids*

The tests under this head have been mainly by the Entomologist, and are designed to prove the value of a simple home-made preparation in the control of various kinds of aphids (plant-lice), instead of relying entirely upon more complicated or less available materials that are often recommended. These tests have now been made upon a number of different kinds of plant-lice, in a number of different years, with favorable results.

5. *Insect Survey*

This work is under general care of the Entomologist, participated in by himself and all interested persons in the Division. Under this project our collections have grown in scope and value, and are constantly used for study and comparison, and to secure material for instruction, exhibits at fairs, farmers' institutes, special meetings, and lectures. Our collection contains many thousands of specimens and represents probably over 2,000 species or kinds, while our records show over 5,000 species of insects now known to be native to North Carolina.

It has not been possible to develop this project in proper proportion to our other lines of work. I feel sure that there is ample opportunity for the employment of one assistant, to be assigned chiefly or exclusively to this permanent line of work, in order that our collections may increase in usefulness.

6. *Field Studies of Black Corn Weevil*

Work on this project was begun a year or two ago; the observations being made by Mr. Leiby and Mr. Sherman, chiefly at the Black Land Farm in Washington County. Our studies show that early maturing corns are exposed to more weevil damage than later maturing corns, and that part of the weevil injury can be avoided by simple methods of management which involve no material expense. In this, our findings agree with those of others.

7. *Mosquitoes and Flies*

The sanitary work undertaken by the Public Health Service, in and around the military camps and shipyards in the State, induced us to begin observations on mosquitoes, for it is the wish of the Public Health service that the work undertaken shall become a basis for State and local work after the war emergency shall have passed. We wish to state clearly that the actual work now under way is the work of the Public Health Service in cooperation with local authorities, and is not in any way under the direction of this Division. This opportunity is merely used to observe and study, in the expectation that the knowledge thus gained may be of future use. The consent and cooperation of the authorities has been given in making observations in vicinities of the shipyards at Wilmington, and Camp Polk at Raleigh. It is presumed that similar work is under way in vicinity of the camps at Charlotte and Fayetteville.

We have observed the drainage work to lessen the breeding of mosquitoes, the screening of kitchens and mess-halls, sewage disposal and care of latrines, and the burning out and burial of used food containers, these being, in brief, the methods chiefly used to control insects which might spread disease. In connection with these observations, we have collected adult mosquitoes in the localities, and have collected wigglers, from which mosquitoes have been reared to maturity, to ascertain which particular kinds are present.

Looking at this matter from the standpoint of the entomologist, Mr. Leiby and others are of the opinion that there should be a trained assistant in this Division, assigned especially to the study of insects in relation to the health and comfort of man. It should be prepared, for example, to cooperate with any county or city undertaking mosquito work, to the extent of locating the chief breeding places, and ascertaining the exact species of mosquitoes which are most abundant or most important in the locality. For all mosquitoes do not spread malaria, and malarial mosquitoes do not breed in all waters. Furthermore, the

most thorough local work will not prevent an invasion by mosquitoes, which may fly long distances with the wind. Such information, which can only be supplied by a specialist assigned to such topics, may often prevent lost motion, useless work, and waste of funds.

8. *Cabbage Dusting to Control Worms*

Under the food emergency, we thought it advisable to conduct tests to demonstrate the safety and effectiveness of dusting cabbages with poisons to control worms. This work has been done by Mr. Leiby at the Mountain Branch Station, with the assistance of Mr. S. C. Clapp, Superintendent. The results were favorable, and convincing photographs were secured which can be made the basis of future advice.

Respectfully submitted,

Franklin Sherman,
Chief Division of Entomology

REPORT OF ENTOMOLOGIST

To the Director:

The Division of Entomology has studied a variety of insects during the past year. These studies have been devoted principally to the life histories, and other relations of a few typical pests. This work has been, for the most part, foundation work, but incidentally some new and exceedingly valuable remedies have been discovered. It is to this latter phase of the problem that we will give most attention in this report.

WORK WITH GLOOMY SCALE

The gloomy scale, which is the most destructive pest of our shade maples, has been investigated. Its life history has been completely worked out. In the course of these investigations a small wasp has been discovered which is very destructive to the scale, killing, at times, as high as 98 per cent of the scale on a tree. Unfortunately this little parasitic wasp is effected very adversely by some unknown factors, and while it may be present in a very beneficial way one year, it may be almost entirely absent the next year. Thus while we may learn to appreciate our little friend, we cannot rely upon it entirely.

Our main recourse, therefore, must be to artificial spraying. During the course of these investigations it has been demonstrated time and again that certain spray solutions called soluble oils are effective against the gloomy scale, whereas certain other solutions such as the lime sulphurs, are not nearly so effective against this pest. Careful investigations have been instigated to determine this point, and while it is believed that the problem has been solved, it will require a little longer to determine whether we have the right solution.

This instance is mentioned as it shows very clearly the painstaking nature of most of the work carried on by this Division. Work that may require years before the true answer is found, but once the answer is found it may be very far reaching in its results. Naturally in such investigations many false clues must be followed, for disproving the false is of as much value as proving the true. Occasionally the question is raised why is it necessary to investigate the life-history of an insect so carefully. The answer is that such an investigation must be made in order to apply the proper remedy.

Again, the gloomy scale investigation will show why this is true. In order to control this pest successfully the trees must be sprayed in the winter after the leaves are off, and before the buds swell in the spring The reason for this is that winter is the only season of the year that mixtures can be applied to the trees that are strong enough to kill the scale and yet not injure the trees. Now, because the injury caused by this scale is not evident in the winter, but is evident in the summer, we frequently have to answer the question as to why cannot a weaker solution be used in the summer, so as to kill the young scale. The answer to this could be had only after several years investigations, during which time we had to report more failures than successes, because the insect is so small and so different to carry through its life cycle. At last, however, the answer has been found. The mother scale often lives more than sixteen months and during at least four of these months she is giving birth to living young. Thus the study of the life-history when it was completed, showed us that in order to kill the young scale, we would have to make repeated applications of weak mixtures which could be only partially successful, whereas, one application of a strong mixture, in the winter, will be many times more successful.

THE BEAN AND PEA WEEVILS

Some one has truly said, from insects there is no escape. Not only do insect pests usually commence their attacks upon the sprouting seeds in the ground, but other successive waves of pests continue the attacks upon the growing plants, while other pests attack the harvested crop, often completely destroying it.

To this latter class belong a group that is generally called the bean and pea weevils. These weevils feed upon the seeds of the bean, garden pea, cowpea, etc. It is not unusual for these weevils to completely destroy the beans or peas in a single season. During the last year we have investigated many phases of this problem, and the following is a summary of the most important points.

These weevils are confined in their choice of food to the seeds of the bean and pea family. The most of the weevils of this group continue to breed in the beans or peas throughout the year, although they are much more destructive in the warm summer months than at any other season of the year. A few weevils in a sack in the spring will produce

enough weevils to completely destroy the stored stock by fall, if left undisturbed. An investigation reported elsewhere shows that more than half a million weevils may develop in a bushel of peas in a single season. The earlier, therefore, the beans or peas are treated, the better.

The two best methods of treating the seed is to store them in air-slacked lime or to kill the weevils by means of heat. The first method has the advantage that the beans or peas need no further attention. It has the disadvantage that the lime may be somewhat troublesome, especially if the seed are used for food or feed purposes. The treatment by heat has the disadvantage that the beans or peas must be watched carefully and treated again if living weevils are discovered at any time.

The amount of lime necessary to use in the first method will vary somewhat with the number of beans or peas stored in one place. For very small amounts, anything less than a gallon, use four times as much air-slacked lime as seed, mix thoroughly and store in bags or boxes. For larger amounts up to, say, two or three bushels, use the same amount of air-slacked lime as there is beans or peas. For amounts up to, say, twenty-five bushels, use one-half as much lime. For larger amounts than this, place the beans or peas in a bin to a depth of not over two or three feet, mix well a small amount of air-slacked lime, say, one bushel to eight or ten or beans or peas, smooth off the top and cover with a layer of lime half an inch to an inch thick.

The air-slacked lime will not injure the beans or peas for food, feed, or seed purposes. When used for food or feed purposes, the lime can be removed easily from the seed by sifting and then washing thoroughly; for seed purposes, the lime need not be removed, but may be sown with the seed.

The beans or peas may be treated by either wet or dry heat. The former is to be preferred if only a few are to be treated, but the latter is much more convenient if there are large amounts. In treating these by the dry method, they may be stored in any fairly tight room or building that can be heated. If there is no stove in the building, an ordinary oil stove is convenient to use. If the room is tightly closed the temperature can easily be raised, in the summer time, from 120 to 140 degrees. It should not be higher than this if the beans or peas are to be used for seed purposes. Higher temperatures will do no harm if they are to be used for food purposes only. This high temperature should be maintained for from three to four hours.

For those who prefer, the beans or peas may be treated by dipping in hot water at about 140 degrees for fifteen to twenty minutes. Water at 140 degrees is slightly hotter than one can bear the hand in comfortably. This treatment will not injure the beans or peas, if they are thoroughly dried after treatment. They should then be stored in tight sacks to prevent weevils gaining entrance from the outside.

THE MELON BEETLES

The melon beetles are among the most destructive insects and they have many interesting relations. The adults generally feed on the leaves of plants, being especially destructive to the leaves of melons and related plants. The grubs, however, feed on the roots of plants.

One kind in particular, the spotted melon beetle, is especially interesting because its grub is so destructive to corn, being known under a variety of names, such as bud worm and root worm. For the past three years this Division has been investigating this insect in cooperation with the Division of Cereal Crop Insects, Federal Bureau of Entomology. Our chief study thus far has been one phase of this problem, the relation between time of planting and destruction by this insect.

In these investigations we have made plantings at five different stations. The plantings have been made every two weeks and carefully inspected every two weeks. This is necessary because a method of planting the grain in a hill and then keeping a careful record of each hill throughout the season has been adopted. The size of this task can be appreciated better when it is known that each planting contains 400 hills and that as a general thing six plantings are made at each of five places each year, and that usually each planting is inspected four times each season. This means the careful inspection of something like 50,000 hills of corn annually and a careful tabulation of the results. The investigations are far from being completed and at the present time no definite conclusions can be drawn.

In this same series of investigations we have conducted some careful experiments against the adults which feed on melons and have shown that a careful dusting of the plants at the proper season will check the pests effectively.

THE TOBACCO FLEA BEETLE

The tobacco flea beetle is the worst insect pest with which the tobacco farmer has to deal. The worst phase being that this pest attacks the tobacco plants from the time they come up in the beds until the crop is harvested and cured. Perhaps the most troublesome part of the problem is the fact that the tobacco farmer cannot get a stand of plants in his beds and when the tobacco is transplanted the beetles are usually abundant enough to kill it outright or to stunt it very badly. As one tobacco farmer expressed it, half of his labors would be ended if he could solve this problem.

The enormous amount that these small insects eat can hardly be appreciated, but a series of careful experiments have shown that each tobacco flea beetle eats more than ten times its own weight each day. This is equivalent to an average man eating a ton of food daily or an average cow eating five tons of hay each day.

After a careful study extending over two years it is believed that this problem has been solved. Briefly the answer may be outlined as follows: (1) careful dusting or spraying of the tobacco beds; (2) dipping the plants at transplanting time; (3) destroying the suckers in the field after the crop is harvested, and (4) destroying the hibernating quarters for the flea beetles. A bulletin giving these points more in detail is now ready for the press and will soon be available for the farmers of the State.

INSECTS AFFECTING ORNAMENTAL PLANTS

The Division of Entomology has not been unmindful of the fact that man, to enjoy life to the utmost, must be placed in beautiful surroundings, and in order to make these surroundings, or the home beautiful he must necessarily use ornamental plants. Most ornamental plants are seriously affected by a host of insect pests, and the Division of Entomology has been studying a number of these for the past several years. These studies have been devoted more especially to the white fly which attacks the privet hedge, and to the euonymous scale which attacks the euonymous hedge. Satisfactory remedies for both these pests have been found and it is hoped to publish these soon.

The Entomologist of the Experiment Station has been interested for a long time in the plant hoppers, a group of insects which attack chiefly the hay and pasturage crops, and during the past year a number of phases of the life-histories of these insects have been investigated. These insects are coming into more and more prominence in this State as hay and pasture become more and more important. We are just now starting a series of experiments on these pests in their relation to alfalfa and other hay crops.

Respectfully submitted,

Z. P. Metcalf,
Entomologist.

REPORT OF DIVISION OF HORTICULTURE

To the Director:

I herewith submit the report of the experimental work of the Division of Horticulture for the fiscal year ending June 30, 1918. The experimental work of the Division is being continued along the lines of the projects described in previous reports.

INVESTIGATIONS WITH PECANS (TRUCK STATION, COASTAL STATION, AND PIEDMONT STATION)

1. *To determine the value of the pecan as a commercial proposition in North Carolina.*—During the winter of 1906-'07, experimental pecan orchards, containing the most important southern varieties, were planted on the Truck Station in Pender County; on the Coastal Plain Station in Edgecombe County, and on the Piedmont Station in Iredell County. At eight years of age, the experimental orchards in the Coastal Plain section of the State produced what might be considered their first commercial crop, while up to the present the trees in the Piedmont section have produced only a few nuts. The results so far secured indicate strongly that, as a commercial proposition, pecan growing should be confined entirely to the Coastal Plain.

2. *Variety testing.*—Twenty-two of the most important southern varieties are included in this test, which has been carried on for eleven years. At this time valuable recommendations regarding pecan varieties for planting in the State can be made. Gratifying results are being secured from the work, as certain varieties are showing marked adaptability to North Carolina conditions, while others are proving to be undesirable. It has been found that certain varieties that are very satisfactory in the Gulf Coast section are almost worthless here, owing to the shorter growing season. It is evident, even from the comparatively short length of time that the investigation has been conducted, that the variety factor is of extreme importance in determining the success or failure of a pecan orchard in this State.

3. *Securing individual tree performance records.*—Performance records of the individual pecan trees in the experimental orchards at the several stations were secured this year, as in former years. It has been noted, as a result of this work, that trees of the same variety, under identical conditions, are uniformly heavy yielders, while others are very poor producers; some producing uniformly large nuts and others uniformly small nuts. As these individual performance records suggest the possibility of improving and standardizing individual yields by bud selection, work has been started along this line.

4. *Cultural practices.*—Investigations to determine the value of correct cultural practices were continued this year. The value of cor-

rect cultural practices, such as tillage, the use of cover crops and leguminous crops, is clearly shown in the increased size of trees, and in the increased size and number of nuts produced, when compared to trees and their products grown in sod.

5. *The value of the different varieties as regards cracking quality.*—The cracking test of the different varieties is made each year. The cracking test is a necessary adjunct to the performance record of a given variety in determining its value in a certain section. Very often a variety is highly satisfactory from a productive standpoint, but the cracking test shows it to be nearly worthless from a utility viewpoint. The cracking test shows the number of nuts per pound, and determines the percentage of unbroken halves the variety will crack out, the percentage of shrunken kernels, the percentage of physiological spot, the percentage of faulty nuts, the shape and size of the kernels, the texture, quality, and flavor of meat, the percentage of meat and the thickness of shell. As a result of these cracking tests conducted each year, certain varieties that were satisfactory from a productive standpoint proved to be totally unsuited to North Carolina conditions.

6. *Top-working methods.*—Progress should be reported in the investigations concerning the top-working pecan trees and the methods employed. The investigations show that good results can be secured by both the "patch bud" method and the "slip bark graft" method. Results indicate that success rests as much in the selection of suitable bud and graft wood as in the technique of the operator.

7. *Pecan breeding.*—The seedlings, as a result of pecan breeding work, that were set in 1915 at the Truck Station, are making a satisfactory growth. During the following year a few nuts are expected.

INVESTIGATIONS WITH PEACHES

1. *Peach breeding work (Truck Branch Station).*—It is the object of this project to produce (a) earlier maturing white and yellow fleshed varieties of peaches, (b) earlier freestone varieties of both white and yellow fleshed peaches, (c) varieties hardier in bud, and (d) varieties with a longer resting period.

Selection, crossing, and production of seedlings are the methods of procedure in this project. To provide working material for this project, a variety orchard containing over 60 different varieties of peaches was planted at the Truck Station during 1917. These trees have made such a satisfactory growth that if favorable conditions prevail, active work on this project can be started next spring.

2. *Variety tests.*—The testing of different varieties on the several branch stations have been continued from year to year.

3. *"Dehorning" peach trees (Piedmont Station and Coastal Plain Station).*—During this last season additional progress with the peach "dehorning" project has been made. From the results so far secured, it

has been shown that in years when the buds are killed by cold, "dehorning" is a profitable practice in renewing old trees. It has been found that the operation may be done relatively late in the spring with satisfactory results.

4. *Summer pruning peach trees* (*Piedmont Station and Coastal Plain Station*).—Progress has been made with the experiments in summer pruning "dehorned" trees. The results so far secured indicate that careful attention should be given to summer pruning, to secure the best shaped trees and the proper distribution of fruit buds. Further investigations, relative to the amount of pruning and the time of pruning, are being conducted.

5. *Summer pruning young peach trees.*—It is a debatable question among fruit growers in the State whether or not it is advisable to summer prune young peach trees to shape them properly. To obtain information on this question, investigations are being conducted from year to year.

INVESTIGATIONAL WORK WITH THERMAL ZONES

The investigational work with thermal zones was inaugurated in a preliminary way in 1909 at the Blantyre Test Farm by W. N. Hutt, to ascertain, if possible, the conditions underlying the phenomena of thermal belts or frostless zones in relation to fruit growing. Two years of preliminary investigation furnished such evidence of the necessity and value of the work that the cooperation of the United States Weather Bureau was secured. Special recording stations were established in various orchards on the mountains where a range in elevation from 1,000 to 4,200 feet was secured. In 1912, the recording stations were increased in number to 15. The field work and records were completed in 1916. Since that time, the vast amount of records collected at the different stations are being worked over by the experts of the United States Weather Bureau, under the direction of Professor Cox of the Chicago Station.

A topographical map of western North Carolina has been prepared with contour lines showing the locations of the observation stations and the mountainous nature of the surrounding country. In order to make this work of practical, as well as of scientific value, a map showing the location of railroads to available fruit zones of 500 feet contours from 1,500 to 3,500 feet elevation is being prepared. This map, in addition to that prepared by the Weather Bureau experts, will be of value to people in securing lands at suitable altitudes for commercial orcharding. The results of these investigations are being prepared for publication.

VARIETY WORK IN POMOLOGY

Observations have been made on the substations, and in commercial orchards throughout the State from year to year, on the behavior of the better known varieties of fruits. Much time and care is taken in writing

and revising descriptions of all of the important varieties of fruits grown in the State. These descriptions are to be used in future publications, and are being used in the office as an aid in identifying varieties of fruit sent in from over the State.

native fruits of north carolina

It is the purpose of this project to determine the place of origin, the history, and to secure descriptions of varieties of North Carolina origin. Each year the data already secured are increased. Where opportunity offered, the descriptions of varieties secured previous to this season were verified or corrected. Paintings and photographs have been made of the most important varieties.

investigations with strawberries (truck station)

The investigations with strawberries were initiated with the intention of determining whether or not there were any other varieties more desirable, as commercial market varieties, than Klondyke and Missionary; the two leading commercial varieties. For this State, the most profitable berry combines the characteristics of productiveness, earliness, and shipping quality. Twenty-three varieties are being tested in comparison with Klondyke and Missionary as regards these characteristics. To determine the shipping value of each of the varieties, shipping tests have been made. Several varieties have proven to be extremly promising, but have not been under observation a sufficient length of time to furnish conclusive information.

the cooperative rotundifolia experiment vineyard (truck station)

The Rotundifolia vineyard, established in cooperation with the United States Department of Agriculture at the Truck Station has furnished, through the work of Mr. Charles Dearing, Assistant Horticulturist of the United States Department of Agriculture, much valuable information regarding the training and management of Rotundifolia grapes, and in the making of grape products. Mr. Dearing has made much progress in the determination of the most desirable varieties, in the breeding of improved strains of existing varieties, and in the production of new varieties of economic importance.

investigational work with sweet potatoes (truck station)

Since North Carolina ranks third in comparison with other states in the number of bushels of sweet potatoes produced, special attention is devoted to the growing and handling of the crop. This Division receives many inquiries for information regarding the crop, but the majority of the questions deals with the choice of varieties and best methods of storing. In order to intelligently answer these questions,

this Division has conducted work with variety testing and sweet potato storage for the last several years.

(1) *Variety tests with sweet potatoes.*—The variety testing of sweet potatoes was continued this season, with 24 varieties under observation. The results secured were largely confirmatory of the work of previous seasons. This work has been in progress for a sufficient length of time to warrant the recommendation of certain varieties.

(2) *Sweet potato storage.*—To carry on this line of work, a model sweet potato storage house was constructed several years ago at the Truck Station. In connection with the variety test, storage tests are being made from year to year to determine the behavior of the different varieties in storage.

Investigations to determine the relation of proper harvesting to keeping quality, the proper method of curing, and the correct management of the house, have been continued this season. As a result of this work, the Division of Horticulture can authoritatively make recommendations regarding varieties for storage, and the most desirable methods to employ in the management of the storage house. The work further shows the advisability of employing houses of this type for storage, as the average loss from all varieties has been less than 5 per cent.

INVESTIGATIONS WITH IRISH POTATOES (MOUNTAIN STATION AND TRUCK STATION)

(1) *Variety testing.*—The testing of varieties of Irish potatoes, to determine the most desirable varieties for western North Carolina conditions, was continued this year with 19 varieties. The testing has been in progress for a sufficient length of time to furnish this Division with the necessary information to make reliable recommendations regarding the choice of varieties for the western part of the State.

(2) *Hill and tuber unit selection work.*—The hill and tuber unit selection method of variety improvement is being employed in an attempt to produce strains of the best varieties with greater productivity and more desirable characters.

(3) *Storage of Irish potatoes.*—With the intention of increasing the usefulness of sweet potato storage houses by utilizing them as a storage house for first crop Irish potatoes, preliminary storage tests have been made to ascertain whether or not this could successfully be done. From the preliminary work, it has been indicated that the houses may be satisfactorily used for preserving the first crop potatoes for two or three months. Such storage facilities would enable growers to take advantage of the advanced prices which prevail after the bulk of the crop has been harvested, and before the fall crop is dug.

Testing South American varieties of potatoes in cooperation with the United States Department of Agriculture (Mountain Station)

The testing of South American varieties of potatoes in cooperation with the United States Department of Agriculture was undertaken in 1916 with the view of producing varieties that would be of economic importance. Crosses have been made with the commercial United States varieties and the South American strains. Progress is being made in this work, but it has not been in operation long enough to provide definite results.

Respectfully submitted,

C. D. Matthews,

Acting Chief, Division of Horticulture.

REPORT OF DIVISION OF HORTICULTURE

To the Director:

I have the honor to submit the following report for the fiscal year ending July 1, 1918:

EXPERIMENTS

During the year, definite progress has been made along several lines, but particularly with reference to the determination of the limits of hybridization of Vitis rotundifolia with other species. Heretofore, very few hybrids of any value have been secured. Two or three years ago a cross was effected between Vitis Bourquiniana Vat. Herbemont and Vitis rotundifolia, but this was practically sterile, and proved to be of little value. This year, we have secured hybrids between Vitis rotundifolia and several other species by using pollen of the former. In all cases, except one, the pollen of other species proved to be impotent, when applied to flowers of V. rotundifolia.

So far it has been almost impossible to secure reciprocal crosses. The one instance in which a reciprocal cross was obtained was in connection with crosses between V. rotundifolia and the European grape, V. vinifera. In this case, when the pollen of V. rotundifolia is used, hybrids are easily secured, but when pollen of V. vinifera is employed hybrids are secured with difficulty. It would seem, therefore, that the matter of prepotency of V. rotundifolia is well established. As further evidence, it is found that even in those seeds which were set in the case of a large number of hybrids secured by using V. vinifera pollen many of the seeds were not viable.

During the year we have secured stock of twenty different species of vitis which are now being grown with a view to the further prosecution of the work of determining the limits of hybridization of V. rotundifolia. One of the interesting points which is to be observed in this work came up in connection with a hybrid between V. rotundifolia and the variety, Concord, which is considered to be a pure Labrusca variety. In view of the fact that up to this time it has been impossible to secure a hybrid between the wild Labrusca and muscadine grapes, the comparative ease with which hybrids were secured with the variety, Concord, when the pollen of V. rotundifolia was used makes it seem probable that Concord is itself a hybrid, containing some vinifera blood.

In the investigations as to color, it has been noted in former years that a pink color appears in the fruits of some of the hybrids, but in all these cases it was impossible to determine the source, because the color of the male parent was not known. This year we have not only secured pink fruited hybrids by using light colored parents, but have also secured one that is self-fertile.

The inheritance of size of berry has also been under investigation and has yielded some striking results. In pursuance of this work a large

number of seedlings of crosses have been studied, particularly with respect to the size of seeds, since this is a potent factor governing the size of berry. Seeds from 270 individual plants from the cross between Thomas and Hope; 419 from the cross between Scuppernong and Hope; and 108 from the cross between James and Hope, were classified in accordance with length, width, and thickness. Those of the first cross were separated into 32 classes; those of the second into 68, and those of the third, into 28. In each case, by comparison of the range of dimensions exhibited in these several classes with that of the parent, it was found that the range of the hybrids of the first generation extended from slightly below the minimum of the one parent, to somewhat above the maximum of the other. This was to be expected in view of the way in which characters in grapes follow Mendel's law. Second generation hybrids will undoubtedly show decisive dominance and recessiveness, and establish the prepotency of the parent involved, thus providing definite information for future work.

NEW PROJECTS

Following are some of the new projects which seem to promise to be desirable to inaugurate:

1. Investigation as to the best stocks and methods of propagation for English walnuts in the South, together with a study of walnut-hickory hybrids, which have already been found at various points in the State. Collection and study of these natural hybrids will prove of considerable value.

2. Investigation to determine means of improvement of Moncelt and other augustifolia, Munsoniana and hortulana varieties of plums. We have accidentally discovered a prune-like variety of plum, and the study of the development of varieties of prunes for this portion of the country might be profitably undertaken in connection with this work.

3. Hybridization of bramble fruits for the particular purpose of determining varieties of raspberries suitable for the South should prove of great value. This is particularly true of those portions of the State in which, at the present time, it is impossible to grow varieties of this most valuable bush fruit.

In closing this report, I wish to again express my appreciation of the high grade of work done by my assistant, Mr. Detjen, and of your own advice and continued interest in the work of this department.

Respectfully submitted

J. P. Pillsbury,
Horticulturist.

REPORT OF THE DIVISION OF PLANT PATHOLOGY AND BACTERIOLOGY

To the Director:

The following report, which is taken largely from the notes of Dr. F. A. Wolf, is designed to cover, in so far as is possible, the work of this Division for the fiscal year ending June 30, 1918. Such work as is not reported herein will remain to be reported upon by Dr. Wolf after his return from the army.

TOBACCO WILDFIRE

The results of this investigation have been reported in Extension Circular 61, from the North Carolina Agricultural Extension Service, and in the *Journal of Agricultural Research,* Vol. XII, No. 7, 449-457.

This heretofore undescribed bacterial disease of tobacco affects the foliage, resulting in the formation of large decayed spots. It has been collected in nineteen counties in North Carolina, three counties in Virginia, and in Wisconsin. The disease originated in the plant bed and was conveyed to the field at the time of transplanting. It is caused primarily by a new species of bacteria. Rains, accompanied by wind, are especially favorable for the spread of the disease. New plant beds and the transplanting to fields not used for tobacco the previous year, should control the disease.

TREMBLES OR MILKSICKNESS

A preliminary report of this investigation appeared in Vol. IX, No. 11, of the *Journal of Agricultural Research.* A more comprehensive report will appear in Technical Bulletin 15, to be issued in July, 1918, from the North Carolina Agricultural Experiment Station. This work was conducted jointly by the Divisions of Plant Pathology and Animal Industry.

An investigation was made of the cause, symptoms and pathological anatomy of the disease, and the nature of the poisonous principles of white snakeroot.

This disorder of domestic animals has been found to be caused by the ingestion of white snakeroot, a weed occurring in the mountainous portions of the State. The disease has been known in the State for about 150 years, and many explanations for its cause have been made. Some believe it due to poisonous minerals, some to germs, and others, to poisonous plants. Man may contract the disease from the milk of cows affected with trembles. The symptoms of the disease are sufficiently characteristic so that any one who has seen an affected animal can recognize it. The heart, liver and kidneys seem to suffer the greatest pathological changes. The active principle is probably glucosidal in nature. Farmers can prevent animals from grazing upon the weed and thus prevent the disease.

INTUMESCENCES ON CABBAGE

A report of this study appeared in the *Journal of Agricultural Research,* Vol. XIII, No. 4.

The pustule-like outgrowth on cabbage whose ultimate cause is injury from wind-blown sand, was studied. Since these structures are related to tumors, galls, knots, etc., the explanation of the proximate cause of all must be the same and is due to an increased hydration capacity of the cell colloids.

BACTERIAL BLIGHT OF SOYBEAN

A report of this work is in manuscript form (F. A. Wolf).

This little known disease has been reported from Nebraska, Connecticut, Wisconsin, and North Carolina. Water-soaked, angular, spots are produced on the leaves and the cotyledons. Infection appears to spread from the cotyledons to the true leaves and from these to other leaves. The primary cause is a bacterium which was isolated and described as a new species (*B. sojae n. sp.*). No evidences of differences in varietal susceptibility of soybeans have been observed. Infected seed are believed to be the chief means by which the disease is carried over winter and by which it is introduced into new localities. The disease is spread in the field by splashing rains.

Considerable extension work has been undertaken upon the diseases of cotton, truck, and forage crops in cooperation with the Office of Cotton, Truck, and Forage Crop Diseases, United States Department of Agriculture. Dr. R. A. Jehle has been appointed to take charge of this work. Dr. Jehle will prepare a report of the extension work for the year.

Further changes in the staff have involved the resignations of A. C. Foster, who entered the Army Medical School at Washington, D. C., and R. O. Cromwell, who returned to the University of Nebraska to complete his graduate work.

The following publications have been prepared by the Division during the year:

1. Tobacco Wildfire, *Jour. of Agr. Res.*, Vol. XII, No. 7, 449-457. 1918. (F. A. Wolf and A. C. Foster.)
2. A Monograph on Trembles or Milksickness and White Snakeroot. N. C. Agr. Exp. Sta., Tech. Bul. 15, July, 1918. (F. A. Wolf, R. S. Curtis, and B. F. Kaupp.)
3. Intumescences, With a Note on Mechanical Injury as a Cause of their Development. *Jour of Agr. Res.*, Vol. XIII, No. 4, 253-260, 1918. (F. A. Wolf).

Respectfully submitted,

W. H. Tisdale,

Acting Chief Division of Plant Pathology.

REPORT OF DIVISION OF MARKETS AND RURAL ORGANIZATION

To the Director:

This report is for the year ending June 30, 1918, and covers the Investigational work of the Division of Markets and Rural Organization, conducted jointly by the North Carolina Department of Agriculture and the North Carolina State College of Agriculture and Engineering, in cooperation with the United States Department of Agriculture, under the agreements and plans entered into by these institutions for the conduct of the work of the Agricultural Experimental Station in the State.

I. INVESTIGATIONS

Cotton

Investigation of cotton prices during the last year has continued along with the grading of cotton at the branch offices maintained at Raleigh, Tarboro, Wilson, and Lumberton. The purpose is to keep in touch with the processes of marketing to see to what extent our grading service is effective in securing farmers a price according to the grade of their cotton, and to give us a line upon producers' prices as compared to prices in other markets. Buyers increasingly are giving up the pernicious habit of buying at a flat rate and are more and more buying on grade. This is particularly true in Edgecombe County, where this Division organized the Edgecombe County Cotton Exchange. The investigations of this last year as well as those of previous years, show many wide discrepancies between prices for the same dates, grades and staples. It seems true for cotton as for potatoes, that the possession of information concerning grades and market quotations does not guarantee that the farmer will be able to sell according to grade and obtain a price which is locally in line with those in primary market centers. The farmer, through organization or otherwise, must have the facilities for placing his products on more than one market in order to obtain the market price based upon grades.

Prices Paid for Cotton by Consumers

Arrangements have been made with a considerable number of North Carolina cotton mills to furnish samples of cotton, the price paid, and the grade contracted for in order to determine consumers' prices and the margin between consumers' prices and producers' prices, or the cost of marketing cotton, and the extent mills obtain the grade of cotton which they contract for. Samples of cotton, together with the data asked for, were furnished for 7,777 bales. A comparison of the prices paid by the mills with the prices received by the producers for the same grades for the same dates, show an average difference of 232 points, or $11.60

per bale. It is estimated that the actual cost, including freight and expense for handling cotton, is $1.60 per bale. This leaves an excess profit of $10 per bale, or on this basis $7,500,000 for North Carolina. The normal or prewar difference between producers' and consumers' prices is from one to two dollars a bale. Thus it would appear that a large part of the $7,500,000 might be saved, if the mills established a central buying agency and the farmers were organized in cooperative selling associations. Some deduction, of course, would have to be allowed on account of the purchases which mills already make direct from producers. A previous survey made by this Division showed that 107 mills were interested in receiving offers from responsible organizations of producers, provided the cotton was classed in large, even-running lots of a given grade and staple by competent State or Federal graders.

Distribution of North Carolina Cotton

The destination of all the cotton (468,159 bales) shipped from 22 towns that are representative of eastern North Carolina, was traced from the records of transportation companies. From this investigation it appears that, whereas North Carolina mills were only consuming 20 per cent of this cotton in 1914, they are now taking over 60 per cent of it. This shows a large shift from export to domestic trade, which should in part be permanent to meet the increased demand of our North Carolina mills.

Damaged Cotton Shipped to Ports

A survey of all the North Carolina cotton received at the ports of Norfolk, Virginia, and Wilmington, North Carolina, during the last four years, was conducted for the purpose of determining the loss to the producers from this source. It was found that 1,463,071 bales contained 51,608 bales damaged to the extent of 1,070,230 pounds that were lost and absolutely worthless and worth about $5,000,000 that had to be sold as "pickings" at a loss of approximately 2½ cents per pound. From this investigation, it appears that the loss to farmers during periods of high prices is not only increased on account of the value of the cotton lost, but that factors make claims for greater pound lossage than occurs.

Warehouse Facilities and Needs

A thorough investigation of the warehouse facilities available in the State was made and seems to indicate that existing facilities are not utilized because of improper location, construction, and conduct. This investigation shows clearly that a properly constructed warehouse, offering reasonable rates and rendering active assistance in the sale of cotton stored in it, will receive a good patronage. One of the greatest faults with the warehouse facilities appears to be their small storage capacity, which does not permit a sufficient volume of business to justify

the employment of a capable man to secure and retain patronage. A report has been made to the Railroad Administration upon this matter, with a recommendation that tariffs be so framed as to influence the erection of large warehouse and compress facilities at designated points within the producing area.

Public Weighers

An investigation has been conducted as to the effect upon prices at primary markets of public weighers and the conclusion reached that unless they are made responsible to some central authority their services hurt rather than help the producer.

Mill Requirements

A survey of the mills of the State has been conducted with the view of ascertaining the quantity and quality of cotton that they consume and what they (the mills) consider the most objectionable features of purchasing more of their supply within the State. This investigation shows that practically all of their objections would be met by the erection of compress and concentration facilities near the centers of production in the State.

Survey of Supply and Methods of Marketing Hogs

A survey of the swine population and market conditions over the State has been made. It shows that approximately 60.7 per cent of the hogs in the State are in the 39 counties lying east of Raleigh. The other 39.3 per cent are in the 61 counties west of Raleigh. Many of the counties east of Raleigh are especially in need of improved marketing conditions of hogs. In many of these counties the supply exceeds the demand, especially during the marketing months. Some few farmers raise enough hogs to market them in carload lots; however, most of the farmers depend upon local markets or shippers for a market for their surplus hogs. Glutted markets and absence of competition often compel farmers to take less for their hogs than they are worth. As a rule farmers in the counties west of Raleigh can dispose of their surplus hogs very satisfactorily on local markets, provided an outlet is kept open to an outside market. If this Division supplies facilities for marketing hogs in those sections where no local shippers operate, the local market will be held in line and the hog industry will be encouraged by the best possible prices obtainable at packing and distributing centers.

A trip was made to Tennessee, Alabama, and Mississippi to study the method of marketing livestock in those states. In many sections the county agent is taking a leading part in assisting farmers market their products. County agents in one district, representing twenty counties, in Mississippi, are reported to have sold products for farmers through associations amounting to $1,575,934.76. These sales included, among

other products, 198 cars of hogs, 144 cars of cattle, and 37 cars of mixed livestock. Undoubtedly the cooperation of county agents is needed if the marketing work is to be carried on in each county of the State.

Monthly Survey of Prices

Monthly survey of prices producers receive for corn, cotton, potatoes, hogs, peanuts, soybeans, and eggs is made to obtain a part of the material for publication in the *Monthly Review of Producers' Prices* and to give this Division information concerning supply and location of products which are for sale cheap in order that we may be in a position to direct inquirers for these products and further to inform us where work needs to be done to develop additional marketing machinery. The *Monthly Review of Producers' Prices,* which is published as an extension circular, has been widely printed by the press of the State.

Survey of the Needs of Farmers for New Marketing and Credit Facilities

The western part of the State, or mountain section, is being canvassed to learn the potato acreage and needs for assistance in marketing late Irish potatoes and livestock, and the eastern part of the State, to determine what counties need assistance in marketing hogs and where cooperative shipments can be developed; and the entire State, to learn communities which are suitable for organizing Credit Unions.

Surveys to Learn Market Needs and to Establish Connection With Possible Buyers

Visits have been made to potato dealers, to flour mills, cotton mills, hog dealers, and packing plants to find out the needs of markets and to establish business connections for farmers who might wish to sell their products in these markets. Several questionnaires and special letters have been mailed to cotton mills, cottonseed oil mills, corn mills, and produce and provision trade to find out possible demand for farm products.

II. ORGANIZATION

The organization work may be divided into two parts, (1) promotion, and (2) maintenance and supervision of organization. The former without the latter has proved dangerous. Marketing organization work in this State has proceeded very slowly, because of the discouragement from previous failures. Several organizations are needed in the western part of North Carolina to market apples, potatoes, and cabbage. A small beginning was made at Waynesville in the fall of 1917, through our organization of the Mountain Growers' Exchange to handle potatoes, apples, and other farm products for its members. A representative of this Division, who is familiar with mountain people and condi-

tions, helped a few growers to organize and later acted as manager to demonstrate the value of cooperative marketing and good business methods. As soon as the Exchange began to operate last fall, the price of potatoes rose from eighty cents to a dollar a bushel, and later in the season, when the Exchange raised the price to $1.20 a bushel, the local buyers raised their prices accordingly. At the same time buyers in Hendersonville were paying only one dollar a bushel. Thus the Exchange had the effect of raising the price of potatoes in the Waynesville section fifty cents a sack to both members and nonmembers. Through this Exchange it is hoped to establish a standard of potato prices for western North Carolina. While the newly established market news service will help inform the small grower of market conditions, organization is necessary to enable him to profit by such knowledge. The Exchange has adopted the United States potato standard, and has graded and sold their potatoes according to this standard. The Exchange has secured two government contracts. In fact, the demand from different markets at good prices was much greater than the growers would sell. Many growers in western North Carolina lost money because they held their potatoes until spring. The policy has been to encourage the growers in other sections to cooperate with the county agents and organize them to ship with the Mountain Growers' Exchange, or in separate associations.

A representative from this Division was loaned to the Carolina Potato Exchange to act as manager through the white and sweet potato season. Seven thousand nine hundred and fifty-eight barrels of Irish potatoes were marketed at an average net price to the grower of $3.10 per barrel and 10,380 barrels of Jersey sweet potatoes at an average net price of $5.28 per barrel to the grower. A representative of this Division was sent to assist the manager of the Tabor Produce Exchange market 2,520 barrels of white potatoes. This Exchange was also assisted to market 10,820 crates of strawberries at an average net price to the grower of $4.71 per crate. Preliminary organization work has been begun to start a potato exchange with central office at Washington, N. C., and branch offices at Aurora, Pantego, Pungo, and other shipping points. This exchange promises to be the largest in the State. Under the Food Administration regulation, which requires that all buyers ship graded stock, it will be easier to organize growers to grade their own potatoes in order to save the ten to fifteen cent charge made by buyers, and to perform the additional function of finding the best possible markets for their members.

The Edgecombe Cotton Exchange, organized by this Division in 1915, during the last year has helped growers to sell their cotton on grade and to obtain the market price. For this purpose its manager receives a daily wire report of cotton prices and of market conditions. At a conference held recently between representatives of the Bureau of Markets and the members of this organization a plan was worked out for the

growers to sign a contract to sell their cotton through the Exchange in order that the manager might know the amount of cotton he has for sale and be able to assemble enough of a given staple and grade to sell to the mills. There is no competition on the Tarboro market where the Exchange is located.

Organization for Credit

During the year four new Credit Unions have been organized, making eighteen now organized, and preliminary work done in the organization of several others. The first Credit Union to be organized among negroes was incorporated this spring with a paid capital of $263.50. This organization will be especially encouraged to show what can be done to promote organized saving and cooperative purchase of farm supplies among negroes. One or more meetings have been held with the members of each of the Credit Unions. A monthly financial statement is issued to the members to show the condition of each Credit Union in a composite report, to encourage saving and depositing funds in the Credit Union and to promote cooperative purchase of supplies and better business methods generally.

The total share capital of the Credit Unions has increased during the year from $4,647.39 to $7,559.52; deposits from $7,664.40 to $11,329.35; loans from $14,518.14 to $21,248.51; and total resources from $19,515.65 to $24,565.79. The amount borrowed from banks decreased from $6,315 to $4,175. One hundred and fifty-six members are borrowers, or 24 per cent of the membership. The loans made averaged $122.36 each.

Only those credit unions are successful which make cooperative purchase of supplies, either through their treasurers or through a separate organization. Cooperative banking among farmers becomes cooperative financing of cooperative purchase of supplies. Fertilizer has been the main supply bought by the credit unions. At Valdese the farmers and mill employees and mill employers cooperate in maintaining a credit union, a supply store, a mutual benefit association and a mutual fire insurance association. One of the beneficent results of these cooperative activities, the director of one of the mills stated, is that the employees are more contented. The plan of a former treasurer of the Lowe's Grove Credit Union was to make the Credit Union the organization through which the whole community is organized. It is certain that cooperative short-time credit is very closely knit with cooperative purchase of supplies. Especially is this true in view of the conclusion reached in a previous investigation, when it was found that 58.4 per cent of the value of the cotton crop was advanced by merchants to farmers in the form of supplies, or approximately supplies worth $30,000,000 at an average rate of 19.2 per cent more on time than for cash.

One of the purposes of the Credit Union is to put its members, including tenants, upon a cash basis, and thus free them from the supply store

system of credit. The credit committee takes the place of the supply merchant. The treasurer of the Carmel Credit Union reports saving $756.11 through enabling members to buy for cash. The plan of operation in this Credit Union, as given by the treasurer, is herewith submitted:

J. M. WALKER, *Pres.* C. M. HUTCHISON, *Vice-Pres.* W. H. PHARR, *Sec. Treas.*

CARMEL CREDIT UNION

CHARLOTTE, N. C., R. F. D. No. 1, March 1, 1918.

Dear Friend:

You want your bank—the Carmel Credit Union—to continue its successful service? Then study these figures.

1917—Loans made, $5,000. Total interest received		$253.03
Where did we get the $5,000.00?		
1917—Capital in shares paid and average deposits	$1,250.00	
Borrowed from bank at 5 per cent	3,850.00	
	$5,000.00	
1917—Total interest paid		134.89
Earnings in interest		$118.14

Undivided profits 1917 sufficient to declare 6¼ per cent dividend on paid up capital. (Added to surplus fund.)

1918 PLAN

Pay 4½ per cent interest to bona fide members on time deposits of six, nine or twelve months.

1918—Capital in shares paid and average deposits	$1,500.00
1918—To bring additional share capital (estimate)	500.00
1918—To bring additional time deposits (estimate)	3,000.00
	$5,000.00

Then:

Interest paid for borrowed money—none.	
Interest on $5,000.00, estimated loans 1918	$ 253.03
Interest on $3,000.00 deposits, average 9 mos.	101.00
Goes to depositors.	
Estimated earnings in interest	$ 152.03

Estimated that share capital by this plan will earn 12 to 15 per cent, at the same time paying bona fide member depositors 4½ per cent on time deposits. (a better rate than any state or national bank pays) keeps the money in the community. Is this not interesting?

Make our bank self-supporting.

State and national banks and trust companies are not seeking loans now, even at 6 per cent. They are investing in Liberty Bonds, War Savings Stamps, etc. May we not show a fine form of patriotism by making our money work at home, for the farmers, enabling us to purchase for cash and in bulk, and thus save to produce more food and feedstuff. Uncle Sam asks for no patriotic service that will mean more toward winning the war.

So bring, send, or mail your deposits in, and now, while you have it on your mind, is the best time.

Cordially yours,

W. H. PHARR,
Secretary-Treasurer.

By Order of the Board of Directors.

One of the obstacles which stands in the way of the success of Credit Unions and of cooperative action among farmers generally, is the vested interests of the present system of business, which as now organized has the power to effectively discriminate against all farmers' organizations. The Credit Unions have found it very difficult to get wholesale rates on wholesale purchases. As long as wholesalers are allowed by the government to discriminate against farmers who pool their purchases in wholesale lots, farmers are going to be deprived of one of the greatest advantages of organizing for cooperative purchase and cooperative short-time credit. It was, therefore, recommended that the Food Administration exercise the authority conferred upon it by section 5 of the Federal Food Control Act to prevent such discrimination, as a war measure to encourage maximum production. The attention of all members of Credit Unions and of farmers generally has been called to the following ruling secured by the Secretary of Agriculture from the principal fertilizer manufacturers and wholesalers:

> "We will in future charge the same price in wholesale lots of not less than thirty ton carloads, or such carload unit as may be fixed by the Car Service Section of the United States Railroad Administration, of the same grade and quality, to individuals or associations, for cash or bankable security, as we do to merchants or dealers in the same locality or f. o. b. factory."

A survey is being made of Credit Unions and Cooperative Purchase Associations to find out their experience in getting wholesale rates in order to make up a list of the wholesalers who are inclined to give favorable terms to farmers' organizations.

III. SERVICE WORK

A considerable part of the service work has already been indicated in connection with the Investigations and Organization work, all of which are for the purpose of service. The Service work of this Division might be summarized under the main heads of (1) cotton grading; (2) assistance to individual farmers and to organizations of farmers; in marketing cotton, potatoes, strawberries, corn, hogs, and soybeans; (3) market news service; (4) assistance in securing short time credit through Credit Unions; (5) assistance in making cooperative purchase of supplies in connection with Credit Unions and other organizations, and (6) assistance in securing long-time credit through the formation of national farm loan associations.

Grading Cotton for Producers

The activities of this project have been chiefly confined to classifying the cotton produced in the counties of Bladen, Carteret, Edgecombe, Green, Martin, Onslow, Pender, Robeson, Sampson, and Wilson, while the cotton was still in the hands of the producers. The plan has been to arrange with the ginners of these counties to send a sample of every

bale of cotton ginned by them, together with the name and address of the owner to one of the grading offices, which were located at Clinton, Lumberton, Raleigh, Tarboro, and Wilson. Upon receipt of the samples at the grading office they were classed and a grade card representing, and numbered to correspond with, each bale, was sent to the owner. With each grade card a sheet was sent showing how many points on or off middling and its equivalent in dollars and cents on a 500-pound bale. A total of 28,862 samples were handled in this manner and enabled the farmers to form an intelligent opinion as to the price of their particular grade of cotton.

Grading for Producers and Middlemen

The classers at the different grading offices classed 11,231 bales directly from the bale itself. In most instances classing of this character should be considered as rendering a valuable service both to the buyer and seller, since it was done at the request of both.

Grading for Consumers

Cotton mills in the State have sent to the grading office located in Raleigh 7,830 samples, together with a statement giving the grade and staple purchased, date of purchase and purchase price. The samples were classed promptly and the mills notified of the grade and staple of each bale.

Results of the Grading Service as a Whole

The different offices classed 47,923 bales and rendered active assistance in the sale of about 12,000 bales. A number of mills and large buyers were informed where they could buy cotton of a particular grade and staple and in most cases were referred to individual producers or organized holders. The data indicates that the service has been worth at least $150,000 in direct money returns to the producers. Merchants, small buyers and local mills have profited appreciably by this grading and marketing service. Our data shows conclusively that the cotton sold in territory contiguous to the grading offices is purchased increasingly on grade. The opposition of buyers is, in some instances, changed to a support of the work after the service has been in operation long enough to show its worth. The opposition of ginners, whenever they may be interested in buying, is one of the greatest obstacles. If this obstacle is removed by State legislation, North Carolina, with very little extra expense, may have a State-wide system of cotton grading. One of the main virtues of this system will be grading the product before it leaves the hands of the farmers.

It appears that the grading work, through obtaining an increasing recognition by buyers of grade and staple, is gradually improving the quality of the cotton produced in North Carolina. There is no doubt but that the average length of staple is longer than it was when the work was instituted.

Marketing

Assistance was rendered in the cooperative marketing of 10,478 barrels of early white potatoes, 1,800 sacks of late white potatoes, usually in less than carload lots; 10,380 barrels of sweet potatoes, 10,820 crates of strawberries, and ten cars of corn.

Assistance was given to farmers in buying seventeen cars of hogs and in selling ten cars. Seven of the seventeen cars bought were obtained from farmers whom we assisted to sell their hogs. The other ten were bought outside the State and consisted of four cars of breeding hogs and six of feeder shoats.

This Division has assisted in marketing an unknown amount of potatoes, corn, soybeans, and other farm products through the suggestions given by correspondents.

Two government contracts for late white potatoes were secured by the Mountain Growers' Exchange. A large amount of farm products could be sold direct to the government with profit to farmers and to the government, and what is vastly more important, with the result of encouraging the permanent organization of farmers generally, that is if the government would lay down the conditions favorable to such sale as it has done in the case of prunes and wool. The discrimination of business against farmers' organizations are so numerous that only the government can establish that equality of conditions which will favor the sale of farm products through organizations of farmers.

In connection with assisting in marketing the 1918 wool clip in the State, a survey of the woolen mills was made. Two mills have government authorization to buy direct from farmers, and are paying from 70 to 75 cents for good clear wool delivered. Farmers have been instructed concerning the government plan for the disposal of the 1918 wool clip through letters and addresses at meetings.

Market News Service

The Market News Service of this Division embraces (1) Daily Bulletins issued in cooperation with the Federal Bureau of Markets; (2) Weekly Price Report, and (3) Monthly Review of Producers' Prices. Daily Market News Service offices were operated during the last eighteen months by this office in cooperation with the Federal Bureau of Markets for the compiling, printing, and distributing reports at Laurinburg for cantaloupes and watermelons, at Elizabeth City for sweet potatoes, at Waynesville for late white potatoes and apples, at Chadbourn for strawberries. Twenty-one thousand and one hundred bulletins from the Laurinburg office were mailed to cantaloupe and watermelon growers and shippers, 13,444 bulletins from the Elizabeth City office to sweet potato growers and shippers, 8,210 bulletins from the Waynesville office

to the growers and shippers of late Irish potatoes and apples, and 8,160 bulletins from the Chadbourn office to the growers and shippers of strawberries. The newly established daily market news service operated at Waynesville by this Division, in cooperation with the Federal Bureau of Markets, brought for the first time news of general market conditions to the small growers of Irish potatoes and apples scattered through the mountains of western North Carolina.

The *Weekly Price Report* quotes prices paid by merchants for corn, oats, wheat, soybeans, cowpeas, Irish potatoes, sweet potatoes, apples, home-made butter, North Carolina creamery butter, eggs, poultry, dressed hogs, country hams, live hogs, peanuts, cotton, cotton seed, and cottonseed meal delivered on twelve of the leading North Carolina towns and corresponding jobbing prices for cotton, corn, hogs, potatoes, butter, cheese, and eggs on one or more of the leading markets of the United States. These reports give the farmer and merchant a basis of comparison of local prices with those of one or more leading markets to show whether home markets are in line. They have proved of value to farmers and buyers to indicate where to sell and buy, and to industrial departments of railroads to show them North Carolina markets.

The *Monthly Review of Producers' Prices* is distributed to farmers, merchants, and the press of the State to show the movement of prices at country loading points and at primary markets, with an effort to interpret conditions to the extent that the facts allow. The policy is to show the facts affecting market conditions. In connection with the early white potato crop a special survey was made of conditions in North Carolina and Virginia, which was published in the *Review* and proved of special service to growers and shippers in guiding them as to the best time for marketing of their crop.

Other Services

Studies were made of types of potato grading machines, requirements of United States Standard Grades for truck crops, and suitable accessible containers for same and their use was encouraged among growers.

Assistance was given in locating high grade sweet potatoes, seed and pure-bred stock.

IV. PUBLICATIONS

Daily Market News Service Bulletins.
Fifty-two Weekly Price Reports.
Eleven issues of the Monthly Review of Producers' Prices written by the staff of the Division of Markets.
Six Farmers' Market Bulletins.
Extension Circular 54, entitled, "Length of Staple of Cotton Produced in North Carolina," by O. J. McCONNELL.
Extension Circular 60, entitled, "What Is a Credit Union," by WM. R. CAMP.
Revised form of Credit Union By-Laws, compiled by WM. R. CAMP.
Ten Monthly Financial Statements of the North Carolina Credit Unions.

Articles on Cotton Grading, Cooperative Purchase of Fertilizers, Value of Market News Service, Cooperative Corn and Hog Marketing, Marketing Home Cured Meats, and Potato Grading were written by the staff of the Division of Markets and published in the Extension News and press of the State.

Respectfully submitted,

Wm. R. Camp,

Chief, Division of Markets; Field Agent in Marketing.

REPORT ON DRAINAGE

To the Director:

I herewith submit the annual report on Drainage for the fiscal year ended June 30, 1918.

The work has been conducted chiefly along the same general lines as in the previous year, with the exception that the experimental maintenance work begun in 1917 on Back Swamp and Jacob Swamp Canals, Robeson County, and on Third and Fourth Creek canals, Iredell County, were not continued this year on account of war conditions.

Mr. F. R. Baker, Assistant Drainage Engineer, entered military service in August, 1917. Mr. F. O. Bartel, Junior Drainage Engineer, of the United States Department of Agriculture, acted in Mr. Baker's place for the six months beginning January 1, 1918.

FARM DRAINAGE

During the past year preliminary and location surveys, designs, and reports for tile drainage systems have been made on 42 farms, in 23 counties, comprising a total area of 2,400 acres. Portions of the systems designed have been installed on some of the farms. Approximately 76,200 feet of tile have been staked out on the ground.

Twenty farms have been visited for the purpose of giving assistance in the location and construction of terraces to prevent hillside erosion, the total length of terraces laid out approximate 181,000 feet.

PRELIMINARY EXAMINATIONS AND RECONNAISSANCE

Three examinations of a preliminary or reconnaissance nature have been made and reports issued, covering a total area of 14,400 acres. A report and specifications for proposed maintenance work in one of the large drainage districts in the State was prepared.

RUN-OFF DATA ON DRAINAGE CANALS

Gaging stations for the determination of run-off have been maintained on Toisnot Swamp Canal, Wilson County, and on Third Creek Canal, Iredell County. The work on Toisnot Swamp was discontinued on December 31, 1917. On Third Creek, the records of daily gage heights are complete from March 17, 1913, to date; those on Toisnot Swamp from March 29, 1914, to December 31, 1917. A paid observed was employed at each place.

Current meter readings of the flow in the canal at the station on Third Creek have been obtained from time to time, for different stages of the water. A run-off curve has been plotted, and from this, and the records of the daily gage heights and rainfall, hydrographs for the years 1913, 1914, 1915, 1916, 1917, and 1818 to date, have been prepared, and a progress report and summary of the work completed.

STUDY OF EFFICIENCY OF UNDERDRAINS

The experiments started in November, 1916, on two of the tile drainage systems installed on Cotton Valley Farm, described briefly in last year's report, have been continued during the past year and are still in progress. The purpose of these experiments is to determine:

1. Amount of run-off from underdrained land
2. Relation of rainfall to run-off.
3. Action of tile drains in lowering the ground water-level.

Considerable progress has been made in assembling and plotting the data obtained and in summarizing some of the results.

Respectfully submitted,

H. M. Lynde,
Senior Drainage Engineer.

PROGRESS REPORT ON RUN-OFF INVESTIGATIONS ON THIRD CREEK, IREDELL COUNTY

By
*H. M. Lynde
Senior Drainage Engineer, United States Department of Agriculture

INTRODUCTION

The investigations upon which this report is based were conducted for the purpose of determining the relation existing between rainfall and run-off from drainage districts in the Piedmont section of the southern states. They were conducted on a canal dredged through Third Creek valley, Iredell County, N. C., and cover a period of approximately five years and nine months, from March 17, 1913, to December 31, 1918. The investigations are still in progress and the writer has had charge of them from the latter part of March, 1913, to date.

GEOGRAPHICAL LOCATION

Third Creek is located in the western part of the Piedmont section of North Carolina. Rising in the southeastern corner of Alexander County, it flows southeasterly through the south central part of Iredell County and into Rowan County, emptying into the South Yadkin River after having joined Fourth Creek, which lies to the north and parallel with Third Creek. Its total length is approximately 38 miles, 6 miles in Alexander County, 21 miles in Iredell County, and 11 miles in Rowan County. Statesville, a town of 5,000 population, is located on the watershed line between Third and Fourth creeks, and is about 2 miles to the north of Third Creek.

TOPOGRAPHY

The watershed area of Third Creek is long and narrow, 2 to 5 miles, with an average width of perhaps 4 miles. The main creek and its numerous tributaries flow through deep valleys, flanked by steep hills on each side. Immediately adjacent to the creek is a narrow strip of flat "bottom land" ranging in width from practically nothing to a maximum of one-half mile, with an average width of between 800 and 1,000 feet. Beginning with the steep rise from the bottoms, the land is rolling for some distance back from the streams, terminating in flat uplands that are very narrow, because of the numerous tributaries which divide the land. The elevation of the watershed above sea level varies from about

*Note.—In accordance with an agreement between the Bureau of Public Roads, United States Department of Agriculture, and the North Carolina Department of Agriculture, the Federal Department has for several years maintained in North Carolina a drainage engineer who is assisted by an engineer provided by the State Department of Agriculture, for the purpose of promoting the practice of farm drainage in this State. This paper has been prepared under this cooperative agreement.

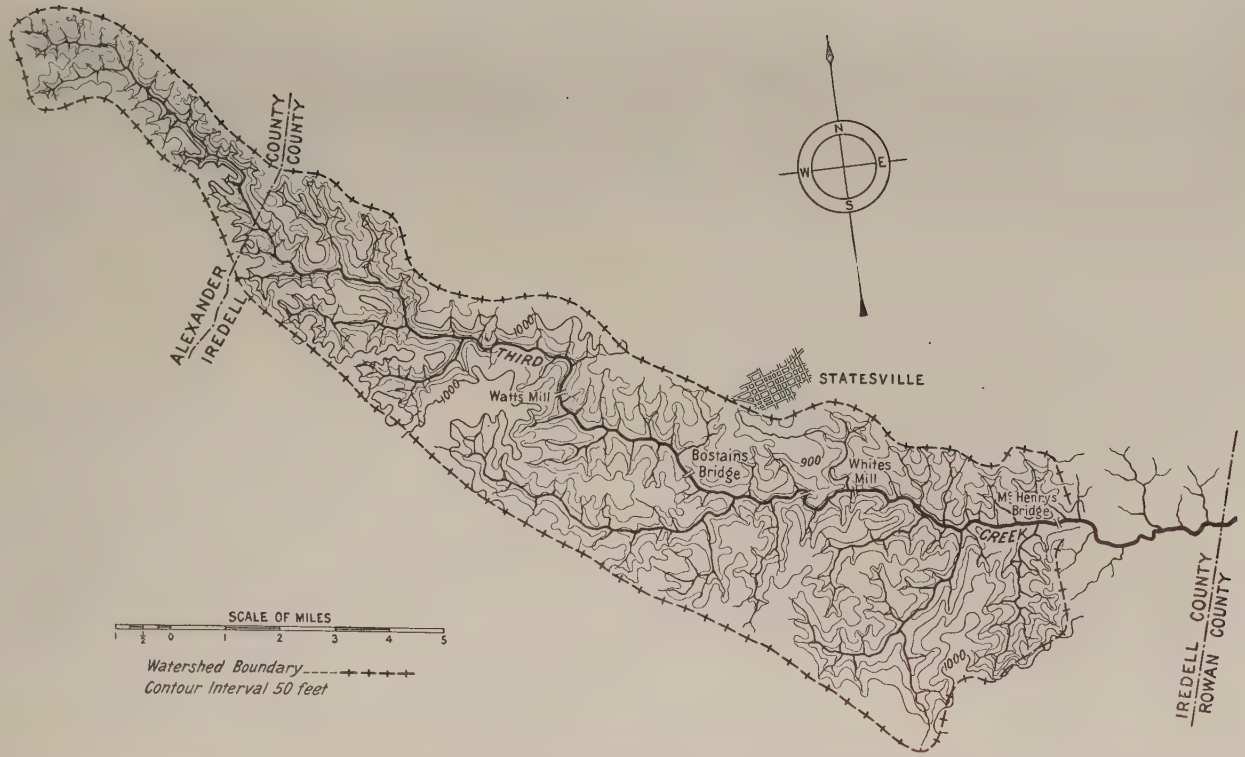

FIG. 1.—WATERSHED MAP OF THIRD CREEK

700 feet in the valley to about 1,000 feet on the uplands. Third Creek valley has a fall of from 6 to 7 feet per mile at the lower end, and about 15 feet to the mile at its upper end (see watershed map, Fig. 1.)

SOILS

The soil in the "bottom land" is classed by the United States Soil Survey as meadow. This soil has been derived from the gradual accumulation of materials brought down by the streams, and generally consists of sandy and silty loams, rich in organic matter. The soil on the uplands is mostly a Cecil clay and Cecil sandy loam, consisting of a heavy red loam from 2 to 7 inches in depth, with an average depth of 5 inches, underlain by a tenacious red clay, possessing, however, good natural drainage.

DRAINAGE CONDITIONS

The bottom lands along Third Creek, as in common with similar streams of this section, probably possess a greater natural fertility than the upland soils. In the early days, they could be cultivated and large crops of corn and hay could be grown on them, but for a period of ten years before 1912, when the creek was dredged, they had been practically abandoned because there was always the menace of the complete loss of the crop by overflow. In times of extremely heavy freshets, the creek would overflow and spread over the bottom, not only damaging the land by an excess of water, but also by depositing sand.

The bed of the creek had been gradually elevated by the deposition of sand and silt, until it was very little lower than the general level of the bottom land. Overflows occurred quite frequently and the constricted and shallow channel prevented its rapid removal. The banks of the creek had been built up and were considerably higher than the general level of the bottoms, the lowest part of the bottoms being usually along the foot of the bluff lines.

DRAINAGE IMPROVEMENTS

Third Creek was one of the first streams in the Piedmont section of North Carolina to be drained. In April, 1910, a preliminary examination of this area was made by the United States Department of Agriculture, which cooperated in making a complete survey during the fall of 1910 after a drainage district comprising a portion of the creek situated in Iredell County was organized under the new State drainage law.

Construction work was begun about January, 1912, and completed in the spring of 1913, covering a distance of about 15 miles from Watt's Mill to the Rowan County line. The ditch ranged in bottom width from 16 to 40 feet, with an average depth of about 9 feet. The grade of the ditch bottom, from the Rowan County line to five miles above McHenry's bridge, is 6.60 feet per mile. Results in general have been satisfactory. In 1915, the district was extended for a distance of about 5 miles into Rowan County.

GAGING STATIONS

A gaging station was established on Third Creek on March 17, 1913, at McHenry's bridge, about 3 miles above the Rowan County line. The drainage area above this point is approximately 44,083 acres, or 69 square miles, as obtained from the United States Geological Survey of this section.

At the time the station was established, the crossing of the creek was made by a temporary bridge connecting up an unimproved highway. In the latter part of 1914, this was replaced by one of a more permanent type, made up of I-beams resting on concrete abutments.

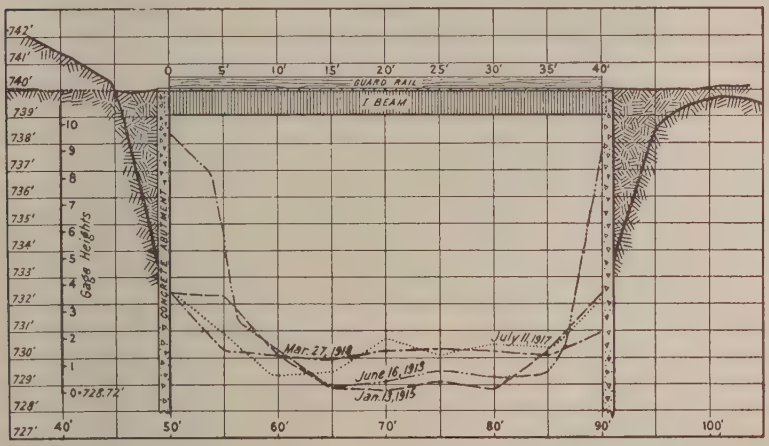

Fig. 2.—Gaging Station at McHenry's Bridge, Facing Down Stream

A gage board, about 11 feet long, marked off in feet and tenths, was installed at a point about 100 feet west of the bridge on the north bank of the creek. Its zero elevation is 728.72, which is well below the surface of the water at minimum flow. Readings of the stage of the water were made daily, usually in the morning; and during the flood periods, twice each day, in the morning and evening. The record of daily gage heights is complete from March 17, 1913, to date.

Mr. J. P. Quinn, who lives near McHenry's bridge, has been employed continuously as gage observer, and since June, 1915, the current meter measurements of velocity have been taken by him. Due to the flashy character of the stream, which rises and falls very rapidly, it is found impractical for the writer, with headquarters at Raleigh, N. C., to get any measurements of value, although this was attempted during the first stages of the work.

The gaging station was carefully cross-sectioned at four different times during the period of the investigations, on the following dates: June 16, 1913, January 13, 1915, July 11, 1917, and March 27, 1918, as shown in Figure 2 accompanying this report.

RAINFALL

The rainfall for the period covered by these investigations was obtained from the United States Weather Bureau records for Statesville, N. C. (Station No. 1.) The summer rains were usually local in character, and often violent, and may have been such as to make the rainfall over the whole watershed considerably different from that shown by the rain gage at Statesville, but it is believed that the records at that place are fairly representative of rainfall conditions.

DISCHARGE MEASUREMENTS

During a period of flood as many current meter measurements of velocity were made at different stages of the water as it was possible to obtain, during both the rise and fall of the stream, and especially at the crest of the flood. However, the observers succeeded in obtaining only two gagings of a rising flood. Measurements were also taken at other stages of water, varying from extreme high water to extreme low water.

In all, 51 discharge measurements have been made for a range of gage height up to 10 feet, all but one since January 1, 1915. Of these measurements, one was made in 1913, 29 in 1915 and 1916, and 21 in 1917 and 1918.

Velocity measurements were made at intervals of 5 feet across the stream at points permanently marked on the bridge floor. A Price current meter was used in obtaining the velocities, measurements being taken at 0.2 and 0.8 of the depth below the water surface. The mean velocity for each 5 foot interval was found by averaging the mean velocities for the vertical lines on each side of the interval, and the discharge for this interval or section was obtained by multiplying this mean velocity by the area of the section. The total discharge of the stream was obtained by taking the sum of the discharge of all the sections. The total daily discharge, where more than one gage height was recorded, was the average of the discharge corresponding to the different gage heights.

The depths used in determining the area of these 5 sections were obtained from the cross-section profiles of the bottom, either previously or subsequently determined at low water. For the years 1915 and 1916, the bottom as obtained on January 13, 1915, was used. For the years 1917 and 1918 the cross section of July 11, 1917, was used. Whether these sections represented accurately the cross sections when the velocity observations were made, is a question. The bottom of the ditch is a

clean, soft sand which scours in time of high water, possibly enlarging the section, although such enlargement is not permanent, since apparently a cross section of the channel taken after a freshet would have been practically the same as one taken before. It is known that the ditch in times of flood carries a large amount of sand in suspension. Once in each day that current meter measurements were made, soundings of the depths of water were also taken, although this was difficult to do accurately at high stages because of the velocity of the water.

Two discharge curves for Third Creek (Fig. 3), one representing conditions existing in 1915 and 1916, and another for the years 1917 and

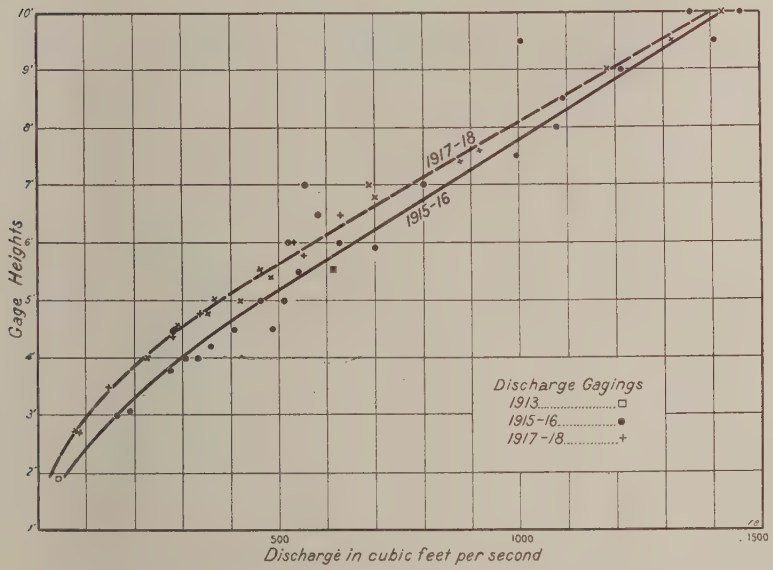

Fig. 3.—Relation Between Discharge and Gage Heights

1918, were drawn, using gage heights in feet as ordinates and the corresponding discharges in cubic feet per second as abscissas, so that for any known stage of stream, the corresponding discharge can be obtained from the curves. Tables were then prepared showing the discharge in cubic feet per second for each 0.1 foot of gage, as scaled from the discharge curves. These tables were then further reduced to show the discharge or run-off in inches in depth per 24 hours over the entire watershed area above McHenry's bridge (44,083 acres).

Hydrographs were then plotted showing together the daily run-off and the daily rainfall at Statesville, N. C. (Figs. 4 and 5), from March 17, 1913, to December 31, 1918, inclusive.

DISCUSSION OF RESULTS

A comparison of the cross sections of the ditch at McHenry's bridge, made in 1913, 1915, 1917, and 1918, indicates that the bottom remained practically constant from 1913 to 1916, inclusive, but was considerably shallower during the years 1917 and 1918, having filled an average of about one foot through the deepest portion. The sides of the ditch prism at the gaging station were earth until the latter part of 1914, when the old bridge was replaced by one with concrete abutments.

Since gage heights are of value in determining measured flow only if the cross section at the gaging station remains practically stationary, or if established for each condition where conditions are changing, two rating curves of gage heights and discharges developed as a result of the material change in the cross sections of 1915-1916 and 1917-1918. Only one measurement of discharge was made prior to 1915, but the 1915-1916 curve is believed to represent fairly accurately conditions in 1913 and 1914, at least up to a gage height of 4.0 feet, and has been used in plotting the hydrographs of that period. The number of times 4.0 feet gage height was exceeded was 10 in 1913 and 15 in 1914.

A study of Third Creek hydrographs shows that this stream is extremely flashy in character, rising very rapidly from minimum to maximum flow and falling just as rapidly almost always within a period of less than 24 hours. It is estimated that the entire run-off from any particular daily rainfall does not require more than 24 hours to reach the main channel and pass off. A study of the hydrographs would seem to indicate that the run-off rate drops low between storms, even though these may occur on successive days, unless the rainfall is extremely intense and nearly continuous. A rainfall of 1 inch in 24 hours, even though carried over a period of several days, usually affects the run-off very slightly.

During the period of the investigations, the daily rainfall was 2 inches or over on 16 days, 3 inches or over on 4 days, 4 inches or over on 1 day, and 5 inches or over on 1 day. The maximum daily rainfall recorded was 5.23 inches on August 31, 1917. This is the largest daily rainfall ever recorded at this station, at least since 1886. The daily run-off was ¼ inch or over on 93 days, ½ inch or over on 41 days, ¾ inch or over on 11 days. Whether the run-off ever equalled 1 inch or more in 24 hours is indeterminate, due to the fact that when the gage reads 10.0 feet, equivalent to a daily discharge of ¾ inch over the watershed area, the ditch overflows its banks at low places along its course.

The maximum gage height recorded was 13.0 feet on August 31, 1917. The number of times that the gage read 10.0 feet or more was 11. It may possibly have reached a height of 10.0 feet or more on several other occasions during the night and so not have been recorded, but these occasions are believed to have been few. At this stage, the water level is just

below the I-beam which supports the bridge, and meter measurements taken for a higher gage height would not have been accurate. It is believed that the discharges are reasonably accurate up to a gage height of 10.0 feet, the maximum which it is possible to obtain on this stream.

Assuming that the ditch overflows its banks when the gage reads 10.0, or more, it is to be noted that overflows have occurred on 11 days during the period of time covered by these investigations, distributed as follows: 2 in 1914, 3 in 1915, 3 in 1916, and 3 in 1917. The overflows in 1914 occurred in October and December; those in 1915 in June, and two in August; in 1916, one in February and two on two successive days in July; in 1917, once in March and two on the last day of August and first day of September. In other words, there have been 9 overflows, 7 of 24 hours' duration or less, and 2 of 48 hours or less but more than 24 hours' duration. Six of them occurred during the growing season, although the crops were well advanced in all but one instance when they occurred.

Whether occasional overflows are permissible and desirable in the drainage districts of the Piedmont section, is a matter about which there seems to be a difference of opinion. Some persons believe that an overflow of short duration is desirable because it adds to the fertility of the land by depositing rich silt. On the other hand, there are serious objections to overflows which have been experienced by several farmers along Third Creek. The creek carries a large amount of sand at flood stages and many of the ditches and small tributaries leading down to the creek become filled with this sand and are completely choked when the water subsides and they have to be cleaned out before satisfactory drainage is secured. In exceptionally heavy freshets, the character of the soil on the bottom land for long stretches may be entirely changed. Instead of depositing rich silt there may be deposited in some places a heavy coating of sand which will render these fields practically worthless for years to come. For a distance of about 2 miles above Bostain's bridge, the people have suffered greatly from overflow. The canal along this stretch follows the old creek channel most of the way and the spoil banks thrown out are composed almost entirely of sand. In times of freshets, the water tends to wash away the spoil banks and flatten them, and cover the land for long stretches with sand. If it were only the water that had to be contended with, it is believed that an occasional overflow of less than 24 hours' duration would do no harm, but in the light of conditions which have been experienced on Third Creek, it is believed that the canals should be of such capacity as to reduce to a minimum the number of overflows, consistent with economy.

According to these investigations, Third Creek canal at McHenry's bridge at bank-full stage is capable of removing in 24 hours, a run-off of ¾ inches upon the watershed area above, and in general, is giving very satisfactory drainage with few overflows. It is believed, however, that a run-off factor of 1 inch should be adopted in the design of canals for Piedmont drainage districts similar to Third Creek.

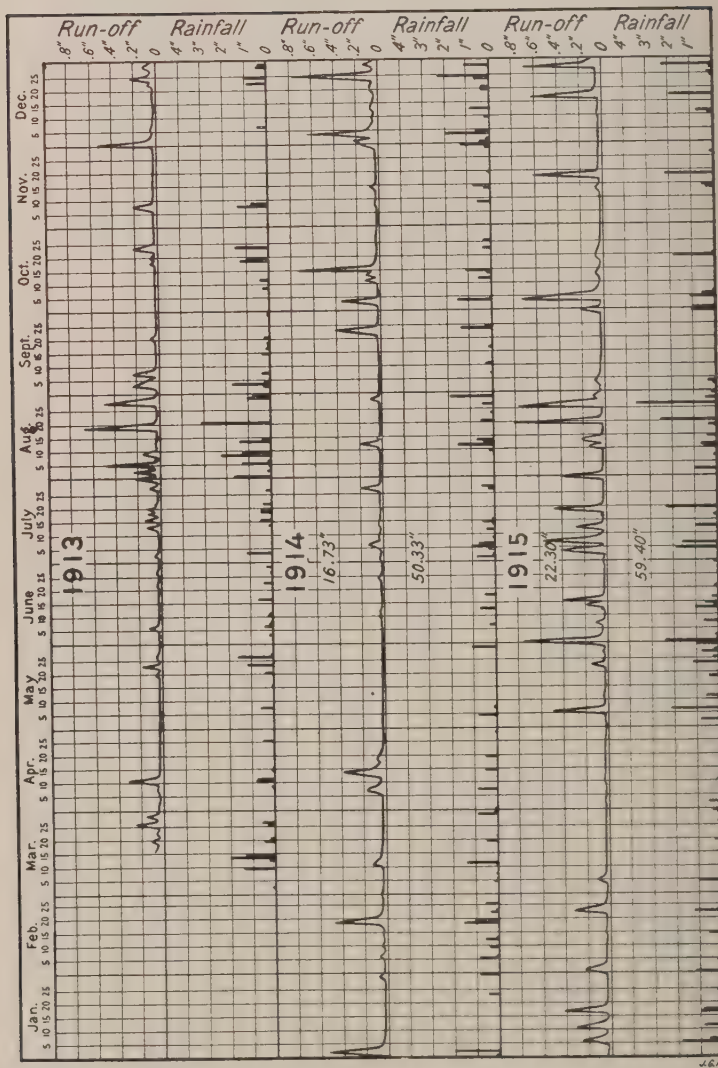

FIG. 4.—RUN-OFF AND RAINFALL, THIRD CREEK, 1913-1915

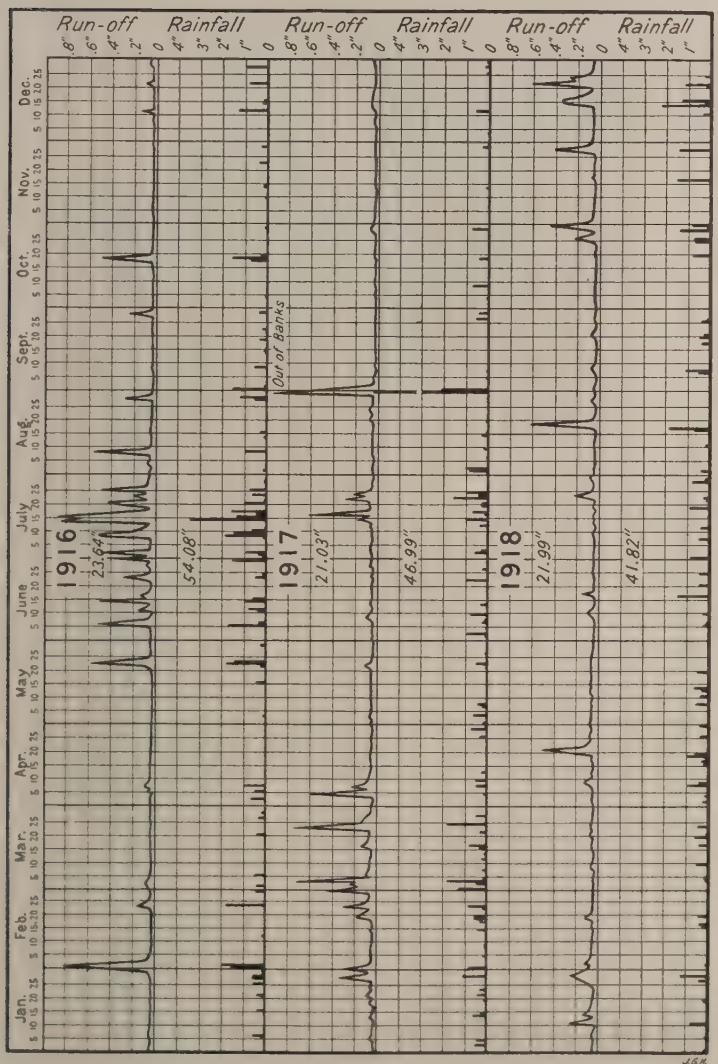

Fig. 5.—Run-off and Rainfall, Third Creek, 1916-1918

No measurements were made of the slope of the water surface, and it is therefore impossible to compute the value of "n" to be used in Kutter's formula with reasonable certainty. It would appear from the investigations, however, that the value is high when the ditch is flowing full, probably as high as .040. For a gage height of 5.0 feet, computations by Kutter's formula, using n=.030 and slope of 6.60 feet per mile, approximate quite closely the discharge as obtained from the discharge curves.

RELATION OF RUN-OFF TO RAINFALL

Table No. 1 shows the rainfall in inches, run-off in inches, and the percentage of rainfall that flowed off for each month during the period of these investigations. These percentages vary considerably and no attempt is made to draw any definite conclusions from them. During some months the run-off exceeded the rainfall, as in April, 1915, November, 1917, and February, 1918. There are four possible reasons for this apparent discrepancy: (1) rainfall late in the preceding month, (2) slight errors in the rating curves, (3) a greater rainfall than the Statesville record shows, and (4) seepage, or ground water that had been stored in previous months. Snowfall is not believed to be an important factor in this section.

The heaviest rainfalls appear to occur mostly during the summer months, but these are largely local in character, and an increase in rainfall does not always show a corresponding increase in the run-off. Furthermore, many of the heaviest rains occurred on very hot days, and evaporation played an important part in taking up the water. Also probably during the summer months the vegetation on the drainage area takes up and utilizes in plant growth large volumes of water which in many cases would otherwise increase the flow in the creek.

A study was made in an endeavor to find some particular season in which the run-off-rainfall ratio was constant every year, but without success. Third Creek never runs dry and the flow is undoubtedly kept up in dry seasons most largely from waters stored in the ground and that gradually flow out and make a perennial stream possible.

It will be noticed that with the exception of 1914, the annual run-off is fairly constant, although the annual rainfall varied considerably. This might seem to indicate that the annual run-off on Third Creek does not vary directly with the annual precipitation, and that variation in the amount of annual rainfall does not affect the run-off. For the five-year period, 1914 to 1918, inclusive, the mean annual run-off was 21.14, and the mean annual rainfall 50.52 inches, a percentage of 42. The difference in the annual percentage of rainfall appearing as run-off in these records may be due to the possibility that the Statesville records do not represent the average rainfall conditions over the entire watershed.

ACCURACY ATTAINED

In presenting this report, it is realized that the data are inexact in some respects. The daily rainfall recorded at Statesville probably does not represent true rainfall conditions over the entire watershed area for any particular storm, but it is believed that for investigations covering a considerable period of time, as these do, they represent fairly the average conditions for the area. Rainfall was recorded only once a day, and flood heights only twice a day; consequently, the actual distribution of precipitation even at Statesville, is shown only roughly, and very likely some flood crests were not recorded. For a stream where the run-off is quick as it is on Third Creek, the lack of more frequent observations is much more important than on streams draining much larger areas, for studying any particular storm or flood, but the data secured warrant the conclusion that for rainfall, topographic, and other conditions like those in Third Creek drainage area, drainage improvements should provide for a run-off of ¾ to 1 inch depth per 24 hours.

Relation of Run-off to Rainfall by Months—Table No. 1

Year	Month	Run-off—Inches	Rainfall—Inches	Run-off Rainfall—Per Cent
1913	April	1.38	2.57	54
	May	1.06	3.93	27
	June	0.87	2.54	34
	July	1.06	3.31	32
	August	2.82	13.71	21
	September	1.34	3.89	35
	October	1.13	4.58	25
	November	0.96	2.14	45
	December	1.61	5.63	29
1914	January	1.58	3.55	45
	February	1.70	5.71	30
	March	1.30	3.61	36
	April	1.90	2.37	80
	May	0.84	2.13	40
	June	0.75	1.67	45
	July	0.99	5.12	19
	August	0.89	6.57	14
	September	0.82	2.33	35
	October	1.79	4.44	40
	November	0.86	3.46	25
	December	3.31	9.37	35
	The year	16.73	50.33	33
1915	January	2.36	5.80	41
	February	1.66	4.02	41
	March	1.19	2.27	52
	April	0.95	0.66	114
	May	1.50	7.92	19
	June	2.21	5.93	37
	July	2.03	7.30	26
	August	3.10	10.11	31
	September	0.89	1.64	54
	October	2.53	4.88	52
	November	1.32	3.26	40
	December	2.54	5.61	45
	The year	22.30	59.40	38
1916	January	1.25	3.48	36
	February	2.51	6.09	41
	March	1.24	2.04	61
	April	1.28	2.38	54
	May	1.56	4.32	36
	June	2.38	7.42	32
	July	6.00	15.46	39
	August	1.92	3.46	56
	September	1.46	1.93	76
	October	1.57	2.85	55
	November	1.03	1.13	91
	December	1.34	3.52	38
	The year	23.64	54.08	44
1917	January	1.61	3.89	41
	February	1.85	3.92	47
	March	4.19	8.19	51
	April	1.98	3.50	57
	May	1.09	2.01	54
	June	1.09	3.98	27
	July	2.10	7.08	30
	August	2.97	7.71	38
	September	1.57	3.29	48
	October	0.82	1.95	42
	November	0.81	0.46	176
	December	0.95	1.01	94
	The year	21.03	46.99	45

TABLE No. 1—Continued

Year	Month	Run-off—Inches	Rainfall—Inches	Run-off Rainfall—Per Cent
1918	January	1.87	2.44	77
	February	1.29	1.12	115
	March	1.24	2.55	49
	April	2.04	4.98	41
	May	1.61	2.50	64
	June	1.34	3.12	43
	July	1.52	4.66	33
	August	2.19	3.65	60
	September	1.34	3.84	35
	October	2.11	4.68	45
	November	1.80	3.06	59
	December	3.64	5.22	70
	The year	21.99	41.82	52

Note.—This work was done and paper prepared under the direction of Mr. S. H. McCrory, Chief of Drainage Investigations.